Materia Medica and Therapeutics

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MATERIA MEDICA

AND

THERAPEUTICS:

AN

Introduction to the Rational Treatment of Disease.

BY

J. MITCHELL BRUCE,

M.A. ABERD., M.D. LOND.,

FELLOW OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON;
PHYSICIAN AND LECTURER ON MATERIA MEDICA AND THERAPEUTICS,
CHARING CROSS HOSPITAL;
ASSISTANT PHYSICIAN TO THE HOSPITAL FOR CONSUMPTION, BROMPTON;
EXAMINER IN MATERIA MEDICA IN THE UNIVERSITY OF LONDON,
AT THE ROYAL COLLEGE OF PHYSICIANS OF LONDON,
AND ON AN EXAMINING BOARD IN ENGLAND.

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PREFACE TO THE FIRST EDITION.

THIS book is chiefly therapeutical in its scope, and is intended to be a rational guide to the student and practitioner of medicine in the treatment of disease. At the same time the MATERIA MEDICA has not been sacrificed. On the contrary, it will be found to be set forth in detail by the adoption of a *natural* and concise arrangement, which presents the subject in such a form that it can be quickly appreciated and easily remembered. The author attaches importance to the plan which he has adopted in the description of the Special Therapeutics, and which consists in systematically tracing the physiological action and uses of the different drugs in their passage through the body, from their first contact with it locally until they are eliminated in the secretions. In the part of the Manual devoted to General Therapeutics he has further departed from the ordinary arrangement, by discussing the actions and uses of remedies, not under the headings of artificial groups, but of the physiological systems of the body (digestion, respiration, etc.), so as to conduct the student from facts with which he is familiar to the great principles of treatment. In using the book the first year's student is recommended to confine his attention to the MATERIA MEDICA proper; and under the action and uses of the drugs, to read only the words printed in thick type.

The author gratefully acknowledges the valuable assistance which he has received in the preparation of the work from his friends Dr. Quain, Dr. Lauder Brunton, and Dr. Frederick Roberts; from his brother, Dr. William Bruce of Dingwall; from Mr. Woodhouse Braine, who kindly sketched the section on the use of anæsthetics; and from his friend and former class-assistant, Mr. A. C. N. Goldney, who has relieved him of much labour by superintending the pharmaceutical portions, drawing up lists, and compiling the index.

The many standard treatises on Materia Medica and Therapeutics in this and other countries have been freely consulted, especially Nothnagel and Rossbach's "Arztneimittellehre," Husemann's "Arztneimittellehre," the works of Wood and Bartholow, and the useful volumes of Squire and Martindale.

PREFACE TO THE THIRD EDITION.

In the preparation of the present Edition, occasion has been taken of the adaptation of the work to the new British Pharmacopœia, to subject it to thorough revision, and to bring the account of the action and uses of the Materia Medica up to the level of our latest knowledge. A change of some importance, which the Author believes will be regarded as an improvement, is the introduction of considerably greater detail respecting the chemical and pharmaceutical relations of the individual drugs. In consequence of these alterations and additions the work has been enlarged to the extent of more than thirty pages.

The Author has again to thank many friends for invaluable advice and assistance. To Mr. Goldney he is under the greatest obligations for the unceasing labour which he has bestowed upon the production of the work from first to last, especially in adapting the preparations to the new Pharmacopœia. Mr. G. E. Rennie and Mr. John P. Harold have also read the proof sheets with the closest care and attention. Lastly, the author desires to express his gratitude to the many critics who have either publicly or privately communicated to him their opinion of former Editions of this work, and who have been pleased to regard with favour the attempt which has been made in it to render Pharmacology and Therapeutics not only intelligible and rational, but at the same time a more agreeable subject of study to the pupils and practitioners of Medicine.

April, 1886.

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MATERIA MEDICA AND THERAPEUTICS.

INTRODUCTION.

MATERIA MEDICA AND THERAPEUTICS relate to the use of drugs in the treatment of disease. The place which these subjects occupy in the Medical Sciences lies, therefore, between Chemistry, Botany, Anatomy, and Physiology on the one hand, and Medicine and Surgery on the other hand; whilst they stand side by side with Pathology, the other stepping-stone from the more purely scientific to the more strictly practical portions of professional education. The student will now be able to turn to account his acquaintance with Chemistry and Biology, and to appreciate the fact that these sciences are the true foundations of all professional knowledge; and when he has reached the end of the volume he may anticipate with some confidence a personal introduction to the treatment of disease.

Let us consider what subjects are comprised under the title, "Materia Medica and Therapeutics."

Materia medica.—This term is applied to the materials or substances used in medicine, their names, sources, physical characters, and chemical properties, the preparations made from them, and the doses in which they may be given.

Therapeutics relates to the treatment of disease, the word signifying healing, from θεραπεύω, *I attend, heal,* or *treat.* It includes, therefore, all that relates to the science and art of healing, not merely by the application of the materia medica to the treatment of disease, but by the use of remedial measures of every kind, including diet, climate, baths, clothing, nursing, and the numerous other means which may be combined to restore health, not the least important being surgical treatment, or surgical therapeutics. This definition is manifestly far too comprehensive for our present purpose, which is concerned only with **medicinal therapeutics,** *i.e.* the uses of the materia medica. When this subject is discussed under the head of each article of the materia medica, as it comes before us in natural order, it is known by the name of the **special therapeutics** of that article. Materia medica and special therapeutics will constitute the first part of the work.

When the numerous and complex facts of special therapeutics are collected and examined, certain great principles may be drawn from them, unfortunately still very far from being perfect, but sufficient to furnish the ground-work for a science of **general therapeutics.** This portion of our subject will be considered in the concluding part of the work.

Certain other terms, variously related to the preceding, must here be defined.

Pharmacodynamics (*φάρμακον, a drug,* that is, either a medicine or a poison, and *δύναμις, power*) is a convenient name for that part of our subject which relates to the action of drugs upon the healthy individual, or, in other words, the **physiological action** of drugs. In the first part of this work the term "action" will simply be used to express the same meaning.

Pharmacology (*φάρμακον, a drug,* and *λόγος, a discourse*) is a term which has been employed in two senses. With the older writers in this country it is the science that relates to the chemical and physiological properties of drugs, their selection and preparation, the extraction of their active principles, and the combination of these with others. More recently the word Pharmacology has come to be used in a wider sense, and to include the whole subject of materia medica and therapeutics, for which it is a short and convenient term.

Pharmacy (φαρμακευτική) is the name applied to the *art* which corresponds with the *science* of pharmacology, the art of making the preparations indicated or ordered by the pharmacologist, and of dispensing the combinations prescribed by the therapeutist. In such a work as the present, the details of pharmacy must be mainly omitted. They have to be learned practically in the dispensary or pharmaceutical laboratory, not by rote from a book.

The Pharmacopœia.—The number of drugs used from time immemorial is enormous, and comparatively few are now believed to be really useful. To separate the valuable *materiæ medicæ* from those supposed to be worthless, books have been published from time to time by the governments or medical authorities of different countries, which furnish an authoritative list of the drugs generally recognised and used by the profession, and the preparations made from them, which have thus become *official* or *officinal.* These books are known as *pharmacopœias* (*φάρμακον, a drug*, and *ποιέω, I make*). In this country we have the British Pharmacopœia, which provides us with a tolerably accurate list of the drugs and preparations in use at the time of its publication. But as pharmacology is a rapidly-advancing science, especially from the direction of chemistry and pharmacodynamics, and as opinion is very unsettled on the subject of therapeutics, the pharmacopœias of different countries differ greatly; and the pharmacopœia of any given country neither is accepted at the time of its publication as perfect in itself and to be followed as an article of faith, nor remains a correct representation of professional opinion for any great length of time. It is, however, an invaluable medium of communication between the physician and the pharmaceutical chemist, whom it furnishes with formulæ for a great variety of preparations of definite composition, and an immense amount of information respecting drugs which is necessary in combining these, or in devising fresh preparations.

Plan of the Materia Medica.—In the Pharmacopœia the materiæ medicæ and their preparations are arranged alphabetically for convenience of reference, but in a systematic treatise they must be discussed in natural order.

The following plan will be adopted in these pages :

PART I.—THE INORGANIC MATERIA MEDICA.

Group 1. Alkalies and Alkaline Earths.
,, 2. The Metals.
,, 3. The Non-metallic Elements.
,, 4. Acids.
,, 5. Water.
,, 6. The Carbon Compounds.

PART II.—THE ORGANIC MATERIA MEDICA.

Group 1. The Vegetable Kingdom.
,, 2. The Animal Kingdom.

Each article will be discussed under several distinct and definite headings, which are as follows : The *names* of the drug, in Latin and in English, its *chemical formula*, if any, and the *definition of its nature ;* its *source ;* its *characters ;* its *composition ;* its *doses ;* and the *preparations* made from it.

A general reference must here be made to each of these headings.

Names, nature, and sources of drugs.—These are sufficiently indicated by the above plan in the case of the inorganic materia medica. It includes many of the chemical elements, and a great variety of compounds of the same.

Vegetable drugs are derived from entire plants, including fungi and lichens, stems (woods), green tops and twigs, roots and rhizomes, barks, leaves, buds, flowers, parts of flowers and flowering tops, fruits and seeds; and various vegetable products, including fixed and volatile oils, resins, oleo-resins, balsams, gums, gum-resins, inspissated juices and secretions. The animal materia medica includes entire animals, portions of animals, and products yielded either during life or after death.

The **methods for obtaining the drugs** will generally be given, and must be learned by the student, who should repeat for himself as many as possible of the easier processes. Most of these are already familiar to him in chemistry, such as *solution*, *filtration*, *evaporation*, *crystallisation*, *precipitation*, *decantation*, *sublimation*, *distillation*, *destructive distillation*, *digestion*, and *washing*. A few specially pharmaceutical processes will, however, require to be defined:

Pulverisation, the powdering of drugs, is done on a large scale in powerful drug-mills. On a small scale it may be done by simple *trituration* (*triturare*, to pound), or powdering in the dry state; by *levigation* (*levigare*, to make smooth or fine), or rubbing down with the aid of a little fluid, the resulting paste being afterwards dried; or by *mediate pulverisation*, in which some very hard substance or medium is mixed with the drug, in order to break up its substance thoroughly. Powdered drugs necessarily require *sifting*.

Elutriation (*elutriare*, from *eluere*, to wash out) consists in diffusing an insoluble powder in water, allowing only the heavier part to settle, and decanting the fluid; allowing this again to settle for a longer time, so as to deposit a second or finer size of powder, and again decanting; and repeating the operation indefinitely until an extreme degree of fineness has been reached.

Lixiviation (*lix*, a lye) is a process of washing an ash or crude mixture of solids, for the purpose of dissolving out the constituents in the form of a lye, or water impregnated with salts, as described under Iodine, page 123.

Maceration and *Percolation* are described under *Tincturæ*, page 16.

Characters.—This part of the description must be studied practically. The characters of a drug are (1) *physical* and (2) *chemical.* (1) In learning the *physical* characters, the student uses the Manual as his guide, and carefully examines specimens of drugs, noting, with respect to each article, its *general appearance*, whether liquid, solid, crystalline, etc.; its *colour*, its *weight*, its *smell*, and its *taste* (if non-poisonous). (2) If convenient, his examination of the drug should follow the pharmacopœial account farther, and include the determination of its *chemical* characters, *i.e.* its *pharmaceutical chemistry*, including its *reaction;* its *solubility* in water, alcohol, ether, oils, etc.; and the *effects of heat* on its volatility, fusibility, etc. The student is expected to know the ordinary *tests* for the salts, including in each instance (*a*) the tests for the *metal*, (*b*) the tests for the *acid*, and (*c*) any *special* test there may be for the compound. In the case of inorganic salts, such as Sulphate of Copper, these tests are purely matters of elementary chemistry, with which the student of materia medica is already familiar; and in this work they will therefore be given only in a condensed form at the end of the account of each metallic element and of each acid respectively. The important reactions characteristic of the organic compounds, such as Morphine and Strychnine, will be stated fully under each. Other important chemical properties, bearing on the pharmaceutical applications of a drug, may have to be studied, especially its *incompatibility* with other drugs, which prevents their combination in preparations.

Along with the characters, the student has, in many instances, to note *impurities*, and the methods of distinguishing substances so like each other as to be very readily confounded.

Impurities may be the result of the imperfect selection, preservation, or preparation of drugs, including chemical decomposition of every kind; or of fraudulent adulteration. Similarity is, of course, a matter of accident, but may give rise to serious error.

The tests of purity applied to *inorganic* drugs are mainly such as are familiar to the student of chemistry; and to avoid constant repetition the most common of them will be represented here once for all:

	Impurity.	*Detected by:*
1. Impurities derived from the sources of the drug, or formed in the process of manufacture and imperfectly removed.	Water.	Bibulous paper; dampness; loss of weight by heat.
	Organic matter.	Blackening on heating.
	Sulphuric acid.	White precipitate with $BaCl_2$.
	Hydrochloric acid.	White precipitate with $AgNO_3$.
	Phosphoric acid.	Yellow precipitate with $AgNO_3$, soluble in HNO_3 and in NH_4HO.
	Carbonic acid.	Precipitate with lime-water; effervescence with acids.
	Sulphurous acid.	Zinc and HCl, which yield H_2S.
	Nitric acid.	H_2SO_4 and $FeSO_4$, which give a brown ring between the two fluids.
	Lime.	White precipitate with oxalate of ammonium, or with CO_2.
	Arsenic.	Yellow precipitate with H_2S.

	Impurity.	*Detected by:*
2. Impurities derived from the apparatus used.	Metals, especially lead, iron, and copper.	Precipitates with $(NH_4)_2S$, or H_2S; and special tests.
3. Insufficient strength.		Volumetric tests.
4. Fraudulent adulterations.	Various coloured earths.	Non-volatility; insolubility in HNO_3.
	Cheap salts.	Various tests.
	Starch.	Blue colour with iodine.
	Sugar.	Evaporation; quantitative test.
	Chalk.	Effervescence with acids.

In the case of *organic* drugs, impurities are chiefly to be detected by careful physical examination and special quantitative tests.

Composition.—The composition of the inorganic drugs is expressed by their name and formula. On the other hand, the organic drugs are frequently highly complex, the chief proximate principles being the following: Fixed oils, volatile oils, resins, oleo-resins, gums, gum-resins, balsams, pectin, alkaloids, acids, neutral substances, glucosides, starch, sugar, cellulose, albuminous substances, ferments, colouring matter, salts, and extractives. Some of these demand general consideration here. A complete list of each will be found on page 420.

Fixed oils are extracted by expression (if possible, without the aid of heat) from the seeds or fruits of plants, or from animal tissues. They are compounds of fatty acids (oleic $H,C_{18}H_{33}O_2$, palmitic $H,C_{16}H_{31}O_2$, and stearic $H,C_{18}H_{35}O_2$, as well as others less common) with the radical glyceryl C_3H_5. With caustic alkalics or metallic oxides they form soaps; the metal combining with the acids, and displacing the glyceryl, which is hydrated, and becomes glycerine $C_3H_5(HO)_3$.

$$\underset{\substack{\text{Hydrate of}\\ \text{Sodium.}}}{3NaHO} + \underset{\substack{\text{Oleate of Glyceryl}\\ \text{(Vegetable Oil).}}}{C_3H_5 3C_{18}H_{33}O_2} = \underset{\substack{\text{Oleate of Sodium}\\ \text{(Hard Soap).}}}{3NaC_{18}H_{33}O_2} + \underset{\substack{\text{Hydrate of Gly-}\\ \text{ceryl (Glycerine).}}}{C_3H_5(HO)_3}.$$

Volatile Oils; Resins; Oleo-resins; Balsams.—Volatile oils are obtained mainly by distillation from entire plants, flowers, fruits, or seeds. Most of them are colourless when pure, and highly aromatic. They are of very different composition. The simplest consist of a liquid hydrocarbon or *elæoptene*, generally isomeric or identical with terpene, the hydrocarbon of oil of turpentine $C_{10}H_{16}$; and of an oxydised hydrocarbon, usually a solid crystalline body, or *stearoptene*, like camphor $C_{10}H_{16}O$. Mixed with these in many instances are various resins, fatty and other acids, and other vegetable constituents. A few volatile oils contain sulphur and nitrogen. Volatile oils are practically insoluble in water, though they communicate their odour and taste to it; soluble in alcohol, ether, and chloroform. Further oxydation converts a portion of volatile oils into *resins* (solid, brittle, non-volatile bodies, insoluble in water); and thus gives rise to *oleo-resins*, which can be broken up into their two constituents by distillation. Resins or oleo-resins yielding benzoic or cinnamic acids are called *balsams*.

Gums are exudations from the stems of plants. They consist of two rather complex carbohydrates, *arabin* $C_{12}H_{22}O_{11}$, and *bassorin* $C_{12}H_{20}O_{10}$, which play the part of acid radicals, and exist in gums as salts of magnesium and potassium. Arabin is soluble in water: bassorin is not soluble, but swells into a gelatinoid mass; the whole product being called a *mucilage*. *Pectin*, vegetable jelly, $C_{32}H_{40}O_{28},4H_2O$, occurs in a few medicinal plants, and, like the *mucilage* yielded by several others, is allied to gum. *Gum-resins* are natural or artificial exudations from plants, containing various proportions of gums and resins, or more frequently of gums, resins, and volatile oils. When finely powdered, and rubbed with water, gum-resins yield an *emulsion*, in which the fine particles of the undissolved resin are held in suspension by the *mucilage* or aqueous solution of the gum.

Alkaloids are active nitrogenous principles formed within organic bodies, which may be regarded as compound ammonias. They resemble alkalies in turning red litmus-paper blue, and form salts with acids. As a rule, they are crystalline solids, rarely liquids; sparingly soluble in water, but readily in alcohol, the solution being intensely bitter.

Organic acids of great variety exist in plants, combined with the inorganic bases, such as potassium and calcium, with alkaloids, or possibly free.

Neutral substances are a very large and mixed group, including: The carbohydrates, such as starch, sugars, gums, etc.; albuminous bodies, which occasionally act as ferments; a few bitter principles; and many of the *glucosides.*

Glucosides are chiefly neutral bodies, capable of being decomposed by acids, alkalies, or ferments, in the presence of water, into glucose and a second substance, which is different in each instance.

The remaining constituents of organic drugs do not call for special notice.

Dose.—The Pharmacopœia suggests the limits within which the different substances and their preparations may be safely given to an adult. These must be carefully learned. The principles of dosage will be presently discussed.

Preparations.—The list of preparations made from the drug, with the principal ingredients, strength, and doses of each, will conclude the account of its pharmacy. This subject demands special consideration here.

Most of the materiæ medicæ possess such characters that it is absolutely necessary to prepare them for administration. Thus, if we take, as examples, Sulphur, one of the elements; Colocynthidis Pulpa, the dried pulp of a fruit; Jalapa, a tuber; and Cantharis, a dried beetle; it is manifest that few of these can be brought into useful contact with the body in their native form. Preparations must be made from them, and for several reasons we must have *a variety of preparations.* First, as we have just seen, substances are very various. Secondly, a substance may contain several active principles, soluble in different media, which it may or may not be desirable to extract together or separately. Thirdly, we constantly wish to obtain *combinations* of drugs, so as to increase, diminish, or otherwise modify the action of each, or to obtain combined action. Fourthly, we must provide for variety of administration or application, externally or internally, to act on a part or to enter the blood by any of the methods of exhibition to be presently described; and we must be ready to meet the tastes and fancies of patients with respect to pills, powders, etc., as well as the necessities of circumstances.

The following are the different kinds of preparations in the British Pharmacopœia. A complete list of each kind will be found in the synoptical tables at the end of Part II.

Aceta, Vinegars, are extractive solutions in acetic acid (not vinegar).

Aquæ, Waters, are very weak simple solutions of volatile oils in distilled water, obtained by distilling (1) some part of a plant, or (2) a volatile oil, with water. Aqua Camphoræ is a solution without distillation. Aqua Chloroformi and Aqua Laurocerasi are the only aquæ not made from an oil.

Cataplasmata, Poultices, are familiar external applications. They generally contain linseed meal as their basis.

Chartæ, Papers, consist of cartridge paper coated with an active compound much like a plaster.

Confectiones, Confections, conserves, or electuaries, are soft, pasty-looking preparations, in which drugs, generally dry, are incorporated with syrup, sugar, or honey.

Decocta, Decoctions, are made by boiling vegetable substances in water from five to twenty minutes, and straining with the addition of water. All decoctions are simple, except that of Aloes and one of the decoctions of Sarsa.

Emplastra, Plasters, are external applications which adhere when applied to the body, and produce either a local or a general effect. The vehicle in all is a compound of fatty substances (resin, wax, lead, soap, etc.), and the preparation is intended to be spread on linen, leather, or other material.

Enemata, Enemas, injections, clysters, are liquid preparations for injection *per rectum.* The vehicle is generally mucilage of starch or water.

Essentiæ, Essences, are solutions of volatile oils in four parts of rectified spirit, *i.e.* are ten times the strength of the ordinary spirits.

Extracta, Extracts, are preparations obtained by evaporating either the expressed juice of fresh plants, or the soluble constituents of dried drugs. They are, therefore, of several kinds :

1. *Green extracts.*—The juice pressed from the bruised plant is heated to 130°, to coagulate the green colouring matter, which is strained off and reserved. The fluid is next heated to 200°, to coagulate the albumen, which is separated by filtration and rejected. The filtrate is now evaporated at 140° to a syrup, the green colouring matter returned, and the whole evaporated down to the required consistence. Ex. : Extractum Aconiti.

2. *Fresh extracts* are prepared like green extracts, but there being no colouring matter, the juice is heated at once to 212° Fahr. to coagulate the albumen, filtered, and evaporated at 160°. Ex.: Extractum Taraxaci.

3. *Aqueous extracts* are prepared by the action of cold, hot, or boiling water on dry drugs, and subsequent evaporation to a proper consistence. Ex.: Extractum Gentianæ.

4. *Alcoholic extracts* are prepared by the action of rectified spirit, rectified spirit and water, or proof spirit on dry drugs, and evaporation to a proper consistence. Ex.: Extractum Physostigmatis.

5. *Ethereal extracts* are prepared in various ways; viz. (*a*) By percolating with ether and evaporating the product: Extractum Filicis Liquidum. (*b*) By making an alcoholic extract, macerating this in ether, and evaporating: Extractum Mezerei Æthereum. (*c*) By washing the drug free from oil, by percolation with ether, before making an aqueous or alcoholic extract: Extractum Stramonii.

6. *Acetic extract.*—The only extract of this kind, Extractum Colchici Aceticum, is made like a fresh extract, but acetic acid is added to the crushed corms before expression, and evaporation is arrested whilst the mass is soft.

7. *Liquid extracts* are prepared by macerating the drug in water, evaporating to form a concentrated solution, and adding a little spirit to prevent decomposition. Ex.: Extractum Pareiræ Liquidum. The process is modified in the case of Filix Mas, as described under ethereal extracts.

The *consistence* of extracts varies much. Some are liquid; four are solid, viz. those of Aloes (2), Hæmatoxylum, and Krameria; five are soft, viz. the Acetic Extract of Colchicum, and the Extracts of Cannabis Indica, Mezereon, Nux Vomica, and Physostigma; the rest are of the consistence suitable for forming pills.

Glycerina, Glycerines, are solutions of substances in glycerine. They are suitable either for further solution or for application locally.

Infusa, Infusions, are obtained by steeping vegetable substances in water, generally near the boiling point, for about an hour, and straining. The infusions of Calumba and Quassia are made with cold water; those of Chiretta and Cusparia with water at 120° Fahr. Those of Orange and Gentian are compound; those of Cinchona and Roses contain acid. Infusion of Kusso is not strained.

Injectiones Hypodermicæ, Hypodermic Injections, are strong solutions of an active drug for administration with a syringe and needle under the skin.

Lamellæ, Discs, are discs of gelatine with some glycerine, containing a fractional quantity of an alkaloid.

Linimenta, Liniments or embrocations, are preparations suitable for application by rubbing, anointing, or painting. All liniments contain either camphor, oil, or soap.

Liquores, Solutions proper, consist of substances other than volatile oils dissolved in water; but the preparations of many are complicated, solution being assisted by spirit, acids, ether, lime, other salts, or carbonic acid as in the effervescing solutions.

Lotiones, Lotions or washes, are solutions or mixtures for external use by washing or on lint. The British Pharmacopœia contains but two lotions, Lotio Hydrargyri Flava, and Lotio Hydrargyri Nigra.

Mella, Honeys, are fluid preparations containing a large proportion of honey.

Misturæ, Mixtures, are made by rubbing up various substances in water, the product being not a solution, but a mixture only. The insoluble substances are generally suspended in the water by means of gum, almond powder, or milk. They are frequently compound.

Mucilagines, Mucilages, are solutions of colloid substances in water.

Oleata, Oleates, are semi-solid compounds of metals with Oleic Acid.

Oleum, an Oil, is a solution in a fixed oil. The Pharmacopœia contains but one: Oleum Phosphoratum.

Pilulæ, Pills, are soft, easily divisible masses, variously composed of extracts, powders, or other active substances, thoroughly mixed and made into an uniform consistent mass with some suitable *excipient*, such as treacle, mucilage, glycerine, soap, confection of roses, or powdered liquorice. Pills are almost all complex. The substances best adapted for giving in pill form are such as cannot from some cause be conveniently given in fluid form, or those intended to act slowly.

Pulveres, Powders, are compounds of dry insoluble substances reduced to powder and intimately mixed and sifted.

Spiritus, Spirits, are either simple or complex. *Simple spirits* are solutions of colourless substances or oils in rectified spirit, the latter of the strength of 1 in 50. Ex.: Spiritus Chloroformi, Spiritus Cajuputi. *Complex spirits* are prepared in a special manner; *e.g.* Spiritus Ætheris Nitrosi.

Succi, Juices, are the expressed juices of the fresh plants, to which one-third of their volume of spirit has been added to preserve them. (Limonis Succus and Mori Succus are not preparations, but natural products.)

Suppositoria, Suppositories, are solid conical bodies, composed of active ingredients and Oil of Theobroma or Glycerine of Starch and Soap, adapted for introduction into the rectum, where they are intended to melt.

Syrupi, Syrups, are fluid preparations containing a large amount of sugar.

Tabellæ, tablets, are small flat pieces of chocolate, containing a minute quantity of an active substance.

Tincturæ, Tinctures, are solutions of active substances in spirit, either alone or combined with other solvents. They may be grouped according to either (1) the *solvent*, (2) the *process*, or (3) the *ingredients*.

1. *Solvents.*—Rectified spirit is chiefly used when the substances contain resin or volatile oil, as in Cannabis Indica; proof spirit when the substances are partly soluble in water, partly in spirit. Ammonia is employed in the Ammoniated Tinctures of Opium, Valerian, Quinine, and Guaiacum; Spirit of Ether in Tinctura Lobeliæ Ætherea; and Tincture of Orange Peel in Tinctura Quininæ.

2. *Processes.*—Tinctures may be prepared by: (*a*) *Simple solution* or mixture. Ex.: Tinctura Ferri Perchloridi. (*b*) *Maceration.* Steep the bruised drug in the spirit for seven days; strain; press, if necessary; filter; and add sufficient spirit to make the desired quantity. Ex.: Tinctura Opii. (*c*) *Percolation.* Pour the spirit on the drug packed in a percolator, and add fresh spirit until the desired quantity has passed through. Ex.: Tinctura Zingiberis Fortior. (*d*) *Maceration and percolation.* Macerate the drug for forty-eight hours in part of the spirit; then percolate, adding more spirit as required; press, filter the products, mix the liquids, and add spirit to make the desired quantity. Ex.: Tinctura Digitalis.

3. *Ingredients.*—Tinctures are either *simple;* or *compound, i.e.* contain more than one active substance. Ex.: Tinctura Benzoini Composita.

Trochisci, Lozenges, are dried tablets of sugar, gum, mucilage, water, and one or more active ingredients, uniformly divided or previously dissolved.

Unguenta, Ointments, are mixtures of active substances with lard, benzoated lard, suet, wax, oil, and hard or soft paraffin, variously combined; or with simple ointment. The ingredients are either thoroughly mixed or melted together.

Vapores, Inhalations, are preparations administered in the form of vapour or gas, disengaged on the union of the ingredients.

Vina, Wines, are solutions of drugs either in sherry, ex.: Vinum Ipecacuanhæ; or in orange wine, ex.: Vinum Quininæ.

The following kinds of preparations are in common use, but are not ordered in the British Pharmacopœia:

Collyria, Eye-washes.

Gargarismata, Gargles, liquid preparations for application to the fauces.

Linctus, Linctuses, thin confections to be slowly swallowed in small doses to affect the throat.

Pessi, Pessaries, a small variety of suppositories for administration *per vaginam.*

Weights and Measures: Signs and Symbols.

The **weights** of the British Pharmacopœia are the grain, *granum;* the ounce, *uncia;* and the pound, *librum;* with their conventional symbols, gr., ℥, and lb. respectively.

1 grain = *granum*, gr. j;
437·5 grains = 1 ounce = *uncia*, ℥j;
16 ounces = 1 pound = *librum*, lb. j.

It is very common, however, although not official, to employ a weight between the grain and the ounce, for the sake of convenience, called the *drachm*, ʒ, to signify 60 grains; not, let it be observed, the $\frac{1}{8}$th part of an ounce, as in the fluid measures.

A 20-grain weight, called the *scruple*, ℈, was formerly in general use, but is now mostly discarded.

Measures.—The measures of the British Pharmacopœia and their symbols are the minim, *minimum*, min., or ♏; the fluid drachm, *drachma fluida*, fl.dr., or *f*ʒ; the fluid ounce, *uncia fluida*, fl.oz., or *f*℥; the pint, *octarium*, O; and the gallon, *congius*, C.

1 minim = min. j, ♏j.
60 minims = 1 fluid drachm, fl.dr. j, *f*ʒj.
8 fluid drachms = 1 fluid ounce, fl.oz. j, *f*℥j.
20 fluid ounces = 1 pint, O j.
8 pints = 1 gallon, C j.

Relations of Weights to Measures.—

1 minim	is the measure of	0·91 grain of water.
1 fluid drachm	„ „	54·68 „ „
1 fluid ounce	„ „	1 ounce, or 437·5 grains of water.
1 pint	„ „	1·25 lbs., or 8750·0 „ „
1 gallon	„ „	10 lbs., or 70000·0 „ „

Metrical system.—The metrical or decimal system of weights and measures, which is official on the continent of Europe, may possibly come to be adopted in this country, as being in many respects preferable to the other:

Weight.	1 milligramme	= the thousandth part of 1 gramme	= 0·001 grm.
	1 centigramme	= the hundredth „ „	= 0·01 „
	1 decigramme	= the tenth „ „	= 0·1 „
	1 gramme	= weight of 1 cubic centimetre of water at 4°C.	
	1 decagramme	= ten grammes	= 10·0 grm.
	1 hectogramme	= one hundred grammes	= 100·0 „
	1 kilogramme	= one thousand „	= 1000·0 „

Capacity.	1 millilitre	= 1 cub. centim.	= the measure of	1 grm. of water.	
	1 centilitre	= 10 „	= „	10 „	
	1 decilitre	= 100 „	= „	100 „	
	1 litre	= 1000 „	= „	1000 „	(1 kilo.)

Relation of the weights of the British Pharmacopœia to the metrical weights.—

1 pound = 453·5925 grammes.
1 ounce = 28·3495 „
1 grain = 0·0648 „

and conversely:

1 milligramme = 0·015432 grain.
1 centigramme = 0·15432 „
1 decigramme = 1·5432 „
1 gramme = 15·432 „
1 kilogramme = 2 lbs. 3 oz., 119·8 gr. = 15432·348 gr.

Relation of the measures of the two systems to each other.—

1 gallon = 4·543487 litres.
1 pint = 0·567936 „ = 567·936 c. centim.
1 fluid ounce = 0·028396 „ = 28·396 „

1 fluid drachm = 0·003549 litre = 3·549 c. centim.
1 minim = 0·000059 „ = 0·059 „

and conversely:

1 cubic centimetre = 15·432 grain measures.
1 litre = 1 pint 15 oz. 2 drs. 11 min. = 15432·348 „

Domestic measures.—A teaspoonful is a convenient but not quite accurate measure of 1 fluid drachm; a dessert-spoonful, of 2 fluid drachms; a table-spoonful, of half a fluid ounce; a wineglassful, of 1½ to 2 fluid ounces; a teacupful, of 5 fluid ounces; a breakfastcupful, of 8 fluid ounces; a tumblerful, of 10 to 12 fluid ounces. Wherever accuracy is desired, a graduated measure glass must be used. Some "drops" being twice as large as others, it is specially dangerous to order drops of powerful remedies for children.

Action and uses of drugs.—The preceding subjects complete the information furnished by the Pharmacopœia; but the student must next make himself acquainted with the action and uses of each drug, that is, its pharmacodynamical and therapeutical relations. In the following pages this portion of the subject will be discussed under four distinct heads, according to the order in which the drug affects the different parts of the body. These are as follows:

1. **Immediate local action.**—When a medicine is applied to an exposed surface, it may produce some effect or "act upon" it. This may occur either *externally*, *i.e.* on the skin or exposed mucous surfaces, such as the conjunctiva, anterior nares, vagina, etc.; or *internally*—on the alimentary canal, especially the stomach and intestines, including the rectum. Some drugs have no further action.

2. **Action in or on the blood.**—The great majority of active remedies are absorbed into the blood, and enter into the composition of its plasma, much less

frequently of the red or white corpuscles; that is, have an effect *in* it, but little or no effect *on* it. The student must carefully note the fact, that very few medicines produce their characteristic effect by acting upon the blood.

3. **Specific action.**—Leaving the circulation, drugs enter the tissues and organs, alter the anatomical and physiological state of one or more of them, and are then said to have a *specific* action upon these. In most instances this is the characteristic and most important part of the action of the drug.

4. **Remote local action.**—Medicinal substances, having passed through the tissues, are finally cast out of the body by the excreting organs, whether in the same form as they were admitted, or as the products of decomposition in the system. The kidneys are the great channel of escape for drugs; the lungs ("breath"), skin, bowels, mouth, mammary gland, and all mucous surfaces and wounds, to a less extent. Whilst thus passing through the excreting organs, the active principles of drugs frequently exert a further or remote local effect upon them, not infrequently resembling their immediate local influence.

Prescribing.—When the practitioner desires to employ drugs for the purposes of treatment, he turns to his knowledge of the action and uses of the materia medica, selects his remedies, and proceeds to order one or more of them, according to a recognised form or formula, which is called a *prescription.* This is a very difficult proceeding when first attempted, being nothing less than a serious and probably sudden practical test of one's acquaintance with an enormous subject. The beginner should know, therefore, what points are specially to be kept before him under these circumstances. Briefly, they may be said to be the following:

1. **Selection of the remedy.**—This is, of course, the first and fundamental proceeding of all. It is

intended to be the rational result of as accurate a knowledge as can be gained of the disease which has to be remedied, and of the means at our command of doing so. How this choice is to be made will be discussed under General Therapeutics in the third part of the work.

Idiosyncrasy.—Before finally deciding, however, on certain drugs, idiosyncracy must not be forgotten; that is, the peculiar susceptibility of some individuals to the action of particular medicines, such as opium, mercury, quinine, essential oils, and ipecacuanha. In almost every instance such idiosyncrasy means *increased* susceptibility; unpleasant or even dangerous results following an ordinary or even minute dose. It is well, therefore, before ordering such drugs, to enquire whether the patient has taken them previously, and if not, to use them cautiously at first.

2. **Selection of the preparation.**—The drug having been determined, the particular preparation of it will be selected in accordance with the considerations discussed under the head of varieties of preparations. The Pharmacopœia affords abundant choice, according to the channel by which it is to be administered. This naturally leads us to consider the

MODES OF ADMINISTRATION OF DRUGS.

The activity of a drug may vary greatly with the channel by which it is introduced, *i.e.* with the readiness or rapidity of its absorption into the circulation. The various modes of administration are:

(*a*) By the *skin*, or mucous membrane continuous with the skin, whether simply applied or rubbed in (liniment, ointment); painted on (pigment); worn on the skin (as a plaster); applied in a state of fine division by fumigation, with or without sweating; used as a gargle, injection, or wash; or insufflated on to a part. The effect desired is usually local only, but it may be general, many drugs being absorbed by the skin.

(*b*) By the *mouth*, to act locally on the alimentary canal, and to be absorbed from it, especially from the stomach.

(*c*) By the *rectum* (or *vagina* in the female), in the form of enema or injection (fluid), or of a suppository (solid). Drugs may have to be given by the rectum instead of by the mouth, on account of some physical obstacle, repugnance on the part of the patient, or irritability of the stomach; or to spare the strength generally, and the stomach especially, in conditions of exhaustion. Again, the action desired may be a local one on the rectum and pelvic organs, *e.g.* to relieve pain, destroy worms, or soften retained fæces.

(*d*) By injection under the skin (*subcutaneous* or *hypodermic injection*); or into the tissues (*interstitial injection*): excellent methods of admitting some remedies into the system with certainty and despatch, and in small bulk.

(*e*) By *application to wounds* or diseased surfaces, as lotions, poultices, gargles, injections, collyria; or by the *endermic* method, *i.e.* by being sprinkled on a blistered surface.

(*f*) By *inhalation*, the substances being volatile, and intended either to enter the blood through the pulmonary capillaries, *e.g.* chloroform, or to act directly on the parts to which they gain access in the form of smoke from medicated cigarettes, of insufflated powders, or of medicated watery vapours, such as Vapor Coninæ.

(*g*) By *intravenous injection*, very rarely practised in man.

3. **The Dose.**—Having selected the remedy and the mode by which it is to be administered, we must next determine the dose in which the preparation is to be ordered. The Pharmacopœia indicates the limits of ordinary doses, the minimum being the smallest useful

dose which it may be wise to begin with, and the maximum being the largest usually given without special reason and caution. Experience alone can teach the practitioner how far he may safely and wisely depart from these limits, to which he is in no wise tied by law. Several modifying circumstances which are to be taken into account with respect to doses must here be carefully noted :

(*a*) Many drugs have *different actions in different doses*, which must be arranged accordingly ; *e.g.* tartar emetic, alcohol, opium, and rhubarb.

(*b*) The dose must vary with the *age* of the patient, children getting but a fraction of a dose for an adult. A convenient method of calculating doses for children under twelve, is to divide the age in years by the age in years + 12, and to use the result as the proper fraction of an adult dose. Thus, for a child of four years the dose will be $\frac{4}{4+12} = \frac{4}{16} = \frac{1}{4}$ of an adult dose ; for a child of twelve, $\frac{12}{12+12} = \frac{12}{24} = \frac{1}{2}$. Above twelve, and under twenty-one, the dose must lie between $\frac{1}{2}$ and a full dose. Delicate persons and patients exhausted by disease resemble children in bearing but small doses.

(*c*) In particular *diseases* the ordinary dose may have to be modified. In disease of the kidneys, where excretion is diminished, drugs which are discharged by this channel, such as morphine, are retained in the system for a longer time, *i.e.* exist in it in larger quantity at any given time after administration, and symptoms of poisoning very readily supervene. Quite a different matter is the effect of a disease in neutralising the effect of a drug given to combat it. Thus, larger doses of morphine will be tolerated in severe pain, because the action of the morphine is spent in overcoming the pain. The periods of menstruation, pregnancy, and lactation also require to be considered in prescribing.

4. **Frequency.**—Medicines are ordered to be taken one or more times, according to the end desired. Thus, purgatives are generally taken in a single dose; an emetic is to be taken once, and repeated only in case vomiting is not induced; whilst tonics are generally ordered three times a day continuously. The interval between the doses should, as a rule, be such that the second dose may be taken before the effect produced by the first has passed off.

5. **Duration.**—The period for which a drug may be given depends on a variety of circumstances which need not be discussed here. We must refer, however, to *accumulation*, *toleration*, *custom*, and *habit*. When a drug is allowed to enter the system at short intervals, for a sufficient period, more rapidly than it can be excreted, a time will obviously come when it will have *accumulated* so much in the tissues as to produce its effects in a marked degree. Powerful drugs, *e.g.* strychnine and digitalis, may thus begin to act as poisons after having been given in the same doses with benefit for weeks. On the other hand, certain drugs lose their effect when given for a length of time, from some cause still obscure, *e.g.* opium. The dose must then be steadily increased, *toleration* being said to be established by *custom*. If a patient become dependent on a drug, crave for it, and indulge in it to an unfortunate or even vicious extent, he is said to have developed a *habit* for that drug, such as the opium and alcohol habits or the habitual use of enemata.

6. **Time.**—The times of the day or night at which the doses must be taken are of the first importance; and speaking generally, it may be said that every advantage must be taken in this respect of the natural tendency which it is desired to assist or stimulate by the drug. Thus, drugs which induce sleep are naturally given at bedtime; alkaline stomachics before meals; saline purgatives early in the morning. The time

required by the drug to act must also be calculated, especially in the case of the different purgatives.

7. Combinations: Chemical and Physiological Incompatibles.—In most instances more than one drug has to be given at the same time, and the practitioner finds that he must combine them in a single prescription, whether, for instance, pill, powder, or liniment. Successful combination is at once the most important and difficult part of the art of prescribing. Whilst it affords the prescriber an opportunity of applying the whole of his knowledge of drugs and their action, it cannot be accomplished without a thorough acquaintance with the physical, chemical, and physiological properties of the ingredients of the proposed compound. The mere appearance, taste, and flavour of a mixture are important points to be considered in ordering it. The chemical reactions which may occur between the constituents must be constantly kept in view. The prescriber may either intend the constituents to remain chemically unchanged, or arrange for the decomposition of one or more of them, and the production of a new substance. Drugs which decompose each other are said to be *chemically incompatible* in the widest sense; but the use of the term is commonly restricted to instances in which the result is an unexpected, inelegant, useless, or dangerous compound. Thus, if it be desired to give a patient chlorate of potassium and hydrochloric acid, we say that the undiluted acid is incompatible with the salt, because chlorine is produced by their combination; but if it be intended to order a fresh solution of chlorine in water, and the decomposition be deliberately planned, the combination would not be considered incompatible. A list of incompatibles will be found after the "characters" of the principal drugs.

The prime consideration, however, will be the physiological effect of the combination. This is very different in different cases. Each of the constituents may be intended to produce an effect different from the others; or to have the same effect; or one or more ingredients may be introduced to modify the action of the principal, that is, to correct some unpleasant, dangerous, or otherwise undesirable influence which it happens to possess in addition to the influence which we wish to secure. Such *correctives* are necessarily physiological antagonists, *i.e.* seem to counteract each other, and appear, therefore, to be *physiological incompatibles;* but it is for this very reason that they are to be combined, because whilst they neutralise the action of each other in certain directions, they are left mutually free to affect other parts of the system. Thus, calomel combined with opium prevents it from causing constipation, whilst it does not interfere with its action on the brain; and the opium, in turn, prevents the calomel from purging the patient, whilst it allows the mercurial to act as an alterative. Most purgative pills contain correctives which moderate the violence of peristalsis and prevent pain.

8. **The Prescription.**—We are now in a position to analyse a prescription. A prescription consists of five parts: The *superscription,* consisting of a single sign, ℞, an abbreviation for *recipe,* "take"; the *inscription,* or body of the prescription, containing the names and quantities of the drugs ordered; the *subscription,* or directions to the dispenser; the *signature,* or directions to the patient, headed by *Signa;* and, lastly, the patient's name, the date, and the prescriber's name or initials. In what may be called a classical prescription, it was customary to arrange the constituents of the inscription under four heads, viz. the *basis,* or active drug proper; the *adjuvant,* or substance intended to assist, and especially to hasten, the action of the basis; the *corrective,* to limit or otherwise modify the same; and the *vehicle* or *excipient,* to bring the whole into a convenient, pleasant form for administration.

To take an example :

Superscription.	℞
Inscription.	Ferri et Ammonii Citratis, gr.v (*basis*).
	Liquoris Ammoniæ Fortioris min.jss. (*adjuvant*).
	Spiritûs Myristicæ, min.vj (*corrective*).
	Infusi Calumbæ, ad ℥j (*vehicle* or *exeipient*).
Subscription.	Misce Mitte doses tales viij.
Signature.	Signa—Two tablespoonfuls twice a day.
Patient's name.	Practitioner's name or initials.
Date.	

It will be seen that the first three parts of the prescription are in Latin ; the signature or directions to the patient in English. The names of the drugs or preparations are in the genitive case, the quantities standing in the accusative case, governed by *recipe :*

Recipe, Spiritûs Myristicæ, minima sex.

Take, of Spirit of Nutmeg, six minims.

A few *abbreviations* and *signs* are allowed, viz. : ℞ for recipe; *m.*, misce ; *S.*, signa; *āā*, ana (ανὰ), of each ; *ft.*, fiat, make ; *q.s.*, quantum sufficit, a sufficiency ; *ad*, up to, to amount to (the full phrase being *quantum sufficit ad*) ; *c̄.*, cum, with ; *no.*, numero, in number ; *p.r.n.*, pro re natâ, as required, occasionally ; *rep.*, repetatur, let it be repeated ; *ss.*, *ſs.*, semi, or semis, a half.

The names of drugs must always be written in full wherever there can be the smallest possibility of error. It is not only inelegant, but dangerous, to use such abbreviations as *Acid. Hydroc. Dil.*, and *Hyd. Chlor.*

The various weights and measures are expressed by characters and figures, very rarely by words, placed distinctly at the end of the line occupied by the name of each ingredient ; but if two or more consecutive ingredients are ordered in equal quantity, it is usual, instead of repeating this each time, to write it only once after the last of them, preceded by the sign *āā*, of each.

Part I.

THE INORGANIC MATERIA MEDICA.

GROUP I.

THE ALKALIES AND ALKALINE EARTHS.

Of the alkalies and alkaline earths, Potassium, Sodium, Lithium, Ammonium, Calcium, Magnesium, Barium, and Cerium are used in medicine.

POTASSIUM. Potassium. K. 39.

The salts and preparations of Potassium are derived from three great natural sources, viz. (1) Wood-ashes; (2) Cream of Tartar; and (3) the native Nitrate. They will be most conveniently discussed in the same order:

1. Potassii Carbonas.—Carbonate of Potassium, K_2CO_3, with about 16 per cent. of water of crystallisation.

Source.—Obtained from pearl-ash, the product of lixiviation of wood-ashes, by solution and crystallisation.

Characters.—A white, crystalline, very deliquescent powder, of caustic alkaline taste; soluble in its own weight of water, insoluble in alcohol. 20 gr. neutralise 17 gr. of Citric Acid, or 18 gr. of Tartaric Acid. *Impurities.*—Sulphates and chlorides.

Dose.—10 to 30 gr.

Potassii Carbonas is used in preparing: Decoctum Aloes Compositum, Enema Aloes, Mistura Ferri Composita, and Liquor Arsenicalis.

From Potassii Carbonas are made:

a. **Potassii Bicarbonas.**—Bicarbonate of Potassium. $KHCO_3$.

Source.—Made by saturating a strong aqueous solution of the Carbonate with Carbonic Acid gas, and recrystallising the separated salt.

Characters.—Colourless right rhombic prisms, not deliquescent; of a saline, feebly alkaline taste; not corrosive. *Solubility*, 1 in 4 of water. 20 gr. neutralise 14 gr. of Citric Acid, or 15 gr. of Tartaric Acid.

Dose.—10 to 40 gr.

Preparation.

LIQUOR POTASSÆ EFFERVESCENS. — Potash Water. Potassii Bicarbonas, 30 gr.; Water, 1 pint. Dissolve, and pass into the solution as much CO_2 as it will contain under a pressure of 4 atmospheres.

Dose.—Ad libitum.

b. **Liquor Potassæ.**—Solution of Potash. KHO (5·84 per cent.) in water.

Source.—Made by boiling Slaked Lime in a solution of the Carbonate, and decanting. $K_2CO_3 + Ca(HO)_2 = 2KHO + CaCO_3$.

Characters.—A colourless alkaline fluid; feeling soapy when rubbed between the fingers. Sp. gr. 1·058. *Impurities.*—Carbonates, giving effervescence with acids; lime, sulphates, and chlorides. *Dose*, 15 to 60 min.

From Liquor Potassæ are made:

a. **Potassa Caustica.**—Caustic Potash. KHO.

Source.—Made from Liquor Potassæ, by rapidly boiling it down in a silver vessel, and pouring it into moulds.

Characters.—White pencils, hard but very deliquescent, alkaline and corrosive. *Impurities.*—The same as of the Liquor.

From Potassa Caustica is made:

Potassii Permanganas.—Permanganate of Potassium. $KMnO_4$. See *Manganesium*, page 89.

β. **Potassii Iodidum.** — Iodide of Potassium. KI. See *Iodum*, page 123.

γ. **Potassii Bromidum.** — Bromide of Potassium. KBr. See *Bromum*, page 129.

c. **Potassii Citras.** — Citrate of Potassium. $K_3C_6H_5O_7$.

Source.—Made by neutralising a solution of Citric

Acid with Carbonate of Potassium, and evaporating. $3K_2CO_3 + 2H_3C_6H_5O_7 = 2K_3C_6H_5O_7 + 3H_2O + 3CO_2$.

Characters.—A white deliquescent powder, of saline, feebly acid taste. *Solubility,* 10 in 6 of water.

Dose.—20 to 60 gr.

d. **Potassii Acetas.** — Acetate of Potassium. $KC_2H_3O_2$.

Source.—Made by saturating Acetic Acid with Carbonate of Potassium, evaporating, fusing, and solidifying the residue. $K_2CO_3 + 2HC_2H_3O_2 = 2KC_2H_3O_2 + H_2O + CO_2$.

Characters.—White, foliaceous, satiny masses; very deliquescent; neutral. The peculiar appearance of this salt is due to crystallisation after fusion. *Solubility,* 3 in 1 of water; freely in spirit. *Impurities.*—The carbonate, detected by being insoluble in spirit; excess of acid, giving acid reaction; metallic impurities.

Dose.—10 to 60 gr.

e. **Potassii Chloras.** — Chlorate of Potassium. $KClO_3$.

Source.—Made by (1) passing Chlorine gas into a mixture of Carbonate or Chloride of Potassium and Slaked Lime; (2) boiling in water, evaporating, and separating the Chloride of Potassium by re-crystallisation. (1) $K_2CO_3 + Ca(HO)_2 + Cl_2 = KCl,KClO$ (Chlorinated Potash) $+ CaCO_3 + H_2O$. (2) $3(KClKClO) = KClO_3 + 5KCl$.

Characters. — Colourless, rhomboidal, crystalline plates, with a cool, saline taste. Explodes when rubbed with sulphur or sulphides. *Solubility,* 1 in 16 of cold water. *Impurities.*—Chloride of Calcium, and Lime.

Dose.—10 to 30 gr.

Preparation.

TROCHISCI POTASSII CHLORATIS.—5 gr. in each.

f. **Potassa Sulphurata.**—Sulphurated Potash. See *Sulphur,* page 133.

g. **Potassii Ferrocyanidum.** — Ferrocyanide of Potassium. $K_4FeC_6N_6,3H_2O$.

Source.—Obtained by fusing animal substances with Carbonate of Potassium and Iron; lixiviating the product; and purifying the crude salt by crystallisation.

Characters.—Large, yellow, permanent crystals, soluble in water, insoluble in alcohol.

From Potassii Ferrocyanidum are made:

α. Acidum Hydrocyanicum Dilutum.

β. **Potassii Cyanidum.**—Cyanide of Potassium. KCN.

Source.—Made by fusing Ferrocyanide of Potassium, and purifying the product. $2K_4FeC_6N_6 = 8KCN + 2FeC + C_2 + 2N_2$.

Characters.—White, opaque, deliquescent masses, with odour of prussic acid; intensely poisonous.

Potassii Cyanidum is used to make:

Bismuthum Purificatum.

2. Potassii Tartras Acida.—Acid Tartrate of Potassium. Cream of Tartar. $KHC_4H_4O_6$.

Source.—Prepared from argol, deposited in wine-casks during the fermentation of grape juice, and from the lees of wine, by purification and evaporation.

Characters.—A white gritty powder, or fragments of crystalline cakes; of a pleasant acid taste; not deliquescent. *Solubility*, 1 in 180 of cold water. When heated, evolves inflammable gas, and leaves a black residue of C and K_2CO_3. *Impurity.*—Tartrate of Lime.

Dose.—20 to 60 gr. as a diuretic and refrigerant; 2 to 8 dr. as a purgative.

Acid Tartrate of Potassium is an ingredient of:

Confectio Sulphuris (1 in 9); and Pulvis Jalapæ Compositus (9 in 15). It is also used in preparing Acidum Tartaricum, Ferrum Tartaratum, Antimonium Tartaratum, and Soda Tartarata.

From this salt is made:

Potassii Tartras.—Tartrate of Potassium. Soluble Tartrate of Potassium. $K_2C_4H_4O_6,H_2O$.

Source.—Made by boiling Acid Tartrate of Potassium in a solution of Carbonate of Potassium, and crystallising. $2KHC_4H_4O_6 + K_2CO_3 = 2K_2C_4H_4O_6 + CO_2 + H_2O$.

Characters.—Small, colourless, deliquescent prisms. *Solubility*, 10 in 8 of water; insoluble in alcohol. *Impurities.*—Acid Tartrate, detected by comparative insolubility; Carbonate, quantitatively. *Dose*, 20 to 60 gr. as a diuretic and antacid; 2 to 4 dr. as a purgative.

3. Potassii Nitras.—Nitrate of Potassium. Nitre. Saltpetre. KNO_3.

Source.—Found native, chiefly in the surface soil of India, and purified by crystallisation from solution in water.

Characters.—Striated colourless prisms, of a peculiar cool saline taste. *Solubility*, 1 in 4 of water. *Impurities.*—Sulphates, Chlorides, and Lime. *Dose*, 10 to 30 gr.

From Potassii Nitras are made :

a. Argenti et Potassii Nitras. See *Argentum*, page 66.

b. **Potassii Sulphas.** — Sulphate of Potassium. K_2SO_4.

Source.—Prepared from Nitrate of Potassium and Sulphuric Acid, which yield the acid sulphate, $KNO_3 + H_2SO_4 = KHSO_4 + HNO_3$; then adding Carbonate of Potassium, to form a neutral salt, $2KHSO_4 + K_2CO_3 = 2K_2SO_4 + H_2O + CO_2$.

Characters.—Colourless, hard, six-sided prisms, terminated by six-sided pyramids. *Solubility*, 1 in 10 of water; insoluble in spirit. *Impurities.*—Other sulphates, and chlorides. *Dose*, 15 to 60 gr.

Potassii Sulphas is contained in : Pulvis Ipecacuanhæ Compositus, 8 in 10; Pilula Colocynthidis Composita, 1 in 24; Pilula Colocynthidis et Hyoscyami, 1 in 36; and Pilula Ipecacuanhæ cum Scillâ, 1 in 3.

c. **Potassii Bichromas.**—K_2CrO_4,CrO_3.

Source. — Made by roasting Chrome Ironstone (FeO,Cr_2O_3) with Carbonate and Nitrate of Potassium, by which Yellow Chromate of Potassium is obtained K_2CrO_4. This, treated with Sulphuric Acid, yields Red or Bichromate of Potassium (K_2CrO_4,CrO_3).

Characters. — Large, red, transparent four-sided tables; anhydrous. Fuses below redness; at a higher temperature is decomposed, yielding green Oxide of Chromium and Yellow Chromate of Potassium, which may be separated by dissolving the latter in water.

Potassii Bichromas is used to make :

Acidum Chromicum and Sodii Valerianas.

GENERAL CHEMICAL CHARACTERS OF POTASSIUM SALTS.

Aqueous solutions acidulated with HCl (1) give a yellow granular precipitate with $PtCl_4$; (2) give a white granular precipitate with $H_2C_4H_4O_6$; (3) impart a light violet or lavender tinge to flame; and (4) do not volatilise when heated.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Potash, in the form of Potassa Caustica, is a powerful irritant and **caustic**, absorbing water from the part to which it is applied, and converting it into a moist, grey slough. It is used to destroy morbid growths, to form issues, and to stimulate ulcers. It is also **antacid**: solutions of the Liquor or of the Carbonates neutralise caustic acids on the skin; hot dilute solutions relieve the pains of rheumatism and gout, when used as fomentations or local baths to the affected joints; and weak compounds of Potash with Olive Oil, constituting Soft Soaps, also have antacid and cleansing properties.

Internally.—Potash and its salts, having an alkaline action, are employed as **antidotes** to the caustic acids; but the use of the Carbonates for this purpose ought, if possible, to be avoided, on account of the great development of carbonic acid which ensues. In the mouth, Potash checks for a moment the secretion of saliva and impairs the appetite. Reaching the stomach it partly neutralises the contents; and Liquor Potassæ Effervescens will relieve acidity due to the decomposition attending indigestion. Of much greater importance is the **stomachic** action of Potash given shortly before meals, when, as a dilute alkali, it is a natural stimulant to the gastric follicles (increasing the flow of the juice), and at the same time is a sedative to the nerves. Liquor Potassæ and the Bicarbonate may be used for this purpose in dyspepsia, especially when there is much pain and tendency to sickness, or when the further action of Potash on the system is desired, as in gouty, rheumatic, and calculous subjects; but Soda is more commonly employed. Large doses of the Bicarbonate are apt to irritate the stomach.

Some valuable **saline purgatives** belong to the Potassium group, notably the Acid Tartrate, Tartrate, and Sulphate. The rationale of the action of saline purgatives is discussed in Part III. In dropsy from any cause, especially ascites from liver disease, the Acid Tartrate, in the form of Pulvis Jalapæ Compositus, of an electuary with honey, or of a lemonade, may be used to remove the water by the bowels, its **hydragogue** effect being assisted by its action as a diuretic.

2. ACTION ON THE BLOOD, AND ITS USES.

Potash is freely absorbed into the blood in the form of salts, and there acts both on (1) the plasma, and (2) the red corpuscles, increasing the natural alkalinity of the former, and improving the quality and increasing the number of the latter when judiciously combined with Iron.

(1) As an **alkaliser** of the plasma it is exceedingly transitory in its action, being very rapidly excreted. Potash is a valuable remedy in gout, where it combines with the excess of uric acid in the blood and facilitates its excretion. The Carbonates, Citrate, and Tartrates of Potassium in various forms, and the waters of such spas as Baden-Baden, Wiesbaden, Vichy, Carlsbad, and Aix-la-Chapelle, which contain definite though small quantities of Potassium salts, are extensively used for the treatment of acute and chronic gout. The salts of the vegetable acids, or the effervescing carbonates, are the best preparations for prolonged use. In acute rheumatism the Bicarbonate, Citrate, Tartrates, and Acetate are successfully employed to increase the alkalinity of the blood.

(2) For restoration of the red corpuscles in anæmia by the increase of their Potassium element, the Carbonate is the best **hæmatinic**, either as contained in the Mistura Ferri Composita, or given as a pill with Sulphate of Iron (Blaud's Pill).

An indirect action of Potassium on the blood must here be carefully noted. We shall see hereafter that Citric, Tartaric, and Acetic Acids, given internally, are partially oxydised in the blood. The completeness of the combustion, and of the important influences which the change exerts on the blood and kidneys, depends upon the combination of the vegetable acid with an alkali. Citric acid *e.g.* is excreted mostly unchanged in the urine, but Citrate of Potassium is entirely, or almost entirely, thrown out as the carbonate.

3. SPECIFIC ACTION AND USES.

Potassium **depresses the muscular, nervous, and cardiac tissues**; and the point of interest in this connection is, that when given for other purposes it must be used with caution. The danger of "potash poisoning" is, however, exaggerated, for the drug passes so quickly through the system that it cannot well produce a deleterious effect on the tissues, unless it be given for a very long time, or in disease of the excreting organs, especially the kidneys. Excessive single doses are generally rejected at once by vomiting.

4. REMOTE LOCAL ACTION AND USES.

Potassium is excreted very rapidly. It escapes almost entirely by the kidneys, to a much less extent by the skin, respiratory passages, stomach, liver, biliary passages, and bowels: in other words, in the fluids of all the secreting surfaces. In doing so it modifies the activity of the cells, and increases the alkalinity of the secretions, as follows:

1. *Kidneys.*—The **diuretic** effect of several Potassium salts,

referable to their influence upon the renal epithelium, is the most important of all; and the Acetate, Acid Tartrate, Citrate and Tartrate, Carbonate, Bicarbonate, and Sulphate are used for this purpose in the order named. These saline diuretics are given chiefly in renal dropsy, where it is desirable to increase the functional activity of the renal epithelium, and thus the secretion both of water and urea, whilst the vessels remain undisturbed. They are also suitable diuretics in feverish conditions. In cardiac dropsy they are less beneficial, as they diminish rather than increase the force of the circulation; but in an occasional full dose they are useful adjuvants, even in this condition, to other classes of diuretics, such as Digitalis and Scoparium, to wash out the tubules. Nitrate of Potassium is a powerful diuretic, belonging partly to a different class, the local vascular stimulants. It is more suitably employed as a diuretic in feverish conditions, and to remove inflammatory effusions into the pleura and pericardium, and must be given with caution in renal disease.

As **alkalisers of the urine**, the Carbonate, Bicarbonate, and the vegetable salts of Potassium are extensively used in uric acid gravel, acute and chronic gout, and acute rheumatism, the latter being preferred because less irritant. In uric acid calculus of the kidney or bladder these salts have been also employed to cause actual solution of the concretions.

2. *Skin.*—The **diaphoretic** effect of Potassium salts is not marked, the Citrate and Nitrate alone being used for this purpose, and these only in mild feverish attacks.

3. *Respiratory Passages.*—The bronchial secretions are increased and rendered less tenacious by Potassium Salts, which are thus **saline expectorants**, the Iodide being specially useful in dry catarrh of the tubes. If the dose of Potash be very large, the secretions are diminished and the mucosa rendered anæmic.

4. *Alimentary Canal.*—*Gastric* catarrh, especially in gouty subjects, is benefited by the milder salts of Potassium, beyond their immediate local effect; but the mineral waters which appear to act in this way, such as those of Vals, Vichy, and Carlsbad, owe their efficiency much more to Sodium. The same remarks apply to catarrh of the *biliary* passages and tendency to gall stones.

The action of Potassium on the *intestinal glands* constitutes it a remote as well as an immediate purgative.

ACTION AND USES OF THE DIFFERENT SALTS OF POTASSIUM.

On reviewing what has been said respecting Potassium, we find that the chief actions and uses of its different salts may thus be briefly represented: *Potassa Caustica;* caustic. *Liquor Potassæ;* antacid and stomachic. *Potassii Bicarbonas, Carbonas,* and *Citras;* antacid, stomachics, alkalisers of the blood and urine, mild diuretics, very mild diaphoretics, saline expectorants, biliary stimulants. *Potassii Tartras, Tartras Acida,* and *Acetas;* the same, but more powerful diuretics; also saline purgatives. *Potassii Sulphas;* chiefly purgative. *Potassii Nitras;* excreted unchanged in the urine; diaphoretic, diuretic, and probably only in this way a mild febrifuge. The remaining salts of Potassium contain, in combination with the alkali, an element or acid possessing such distinctly specific actions that the total effect is but in a minor degree referable to the former. *Potassii Chloras;* excreted unchanged in all the secretions, including the saliva; is much used in inflamed, ulcerated, and aphthous states of the mouth. The *Arsenite, Bromide, Iodide, Permanganate,* and *Sulphurated Potash* will be respectively discussed under the head of their other constituents. *Ferrocyanide* is used as a test, and in the preparation of the *Cyanide,* which is employed only in the manufacture of Purified Bismuth.

SODIUM. SODIUM. Na. 23.

There are four great sources of the official salts of Sodium and their preparations, viz. (1) Metallic Sodium, (2) the Chloride, (3) the native Nitrate, and (4) native Borax. They may therefore be arranged as follows:

1. Sodium.—A metallic Element.

Characters.—Soft, rapidly oxydising, showing a bright metallic surface when freshly cut. Decomposes water, and must be kept under naphtha.

From Sodium is prepared:

Liquor Sodii Ethylatis.—*See* page 174.

2. Sodii Chloridum.—Chloride of Sodium. Common Salt. NaCl.

Source.—Native.

Characters.—Small white crystalline grains, or transparent cubic crystals, free from moisture, with purely saline taste. *Solubility,* 1 in 2¾ of water. *Dose,* 10 to 240 gr.

Sodii Chloridum is used in making:

Acidum Hydrochloricum, Hydrargyri Perchloridum, and Hydrargyri Subchloridum.

From Sodii Chloridum is derived:

Sodii Carbonas.—Carbonate of Sodium. $Na_2CO_3, 10H_2O$.

Source.—Made from Chloride of Sodium, by reaction with Bicarbonate of Ammonium, and subsequent ignition. Or by (1) conversion into Sulphate, and (2 and 3) the action of heat on a mixture of the Sulphate with Carbon and Carbonate of Calcium. (1) $2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl$. (2) $Na_2SO_4 + C_4 = Na_2S + 4CO$. (3) $Na_2S + CaCO_3 = Na_2CO_3 + CaS$.

Characters.—Transparent, colourless, laminar rhombic crystals, efflorescent; with a harsh alkaline taste, and alkaline reaction. *Solubility.*—1 in 2 of water; insoluble in alcohol. 20 gr. neutralise 9·8 gr. Citric Acid, or 10½ gr. Tartaric Acid. *Impurities.*—Sulphates and chlorides.

Dose.—5 to 30 gr.

From Sodii Carbonas are made:

a. **Sodii Carbonas Exsiccata.**—Dried Carbonate of Sodium. Na_2CO_3. A dry white powder, made from Carbonate of Sodium by drying and heating to redness. 53 gr. = 143 gr. of the crystallised salt. *Dose,* 3 to 10 gr.

b. **Sodii Bicarbonas.** — Bicarbonate of Sodium. $NaHCO_3$.

Source.—Prepared by saturating the Carbonate with Carbonic Acid gas, $Na_2CO_3 + H_2O + CO_2 = 2NaHCO_3$; or by reaction of Chloride of Sodium and Bicarbonate of Ammonium.

Characters.—A white powder, or small opaque irregular scales, of a saline, not unpleasant, taste. *Solubility.*—1 in 10 of water. 20 gr. neutralise 16·7 gr. of Citric Acid, or 17·8 gr. of Tartaric Acid. *Impurities.*—Carbonate and its impurities.

Dose.—10 to 60 gr.

Preparations.

α. LIQUOR SODÆ EFFERVESCENS.—Soda Water; made like Potash Water. 30 gr. in 1 pint. *Dose,* ad libitum.

β. TROCHISCI SODII BICARBONATIS.—5 gr. in each, with Sugar, Gum, and Water. *Dose,* 1 to 6.

γ. SODII CITRO-TARTRAS EFFERVESCENS. — White deliquescent granules. Made by heating the Bicarbonate with Citric and Tartaric Acids and

Sugar; stirring until the powder assumes a granular form. *Dose*, 60 to 120 gr.

c. **Liquor Sodæ.**—Solution of Soda. NaHO (4·1 per cent.) in water.

Source.—Made by boiling Slaked Lime in a solution of Carbonate of Sodium, and decanting. $Na_2CO_3 + Ca(HO)_2 = 2NaHO + CaCO_3$.

Characters.—A colourless alkaline liquid; sp. gr. 1·047. *Impurities.*—Lime, carbonates, sulphates, chlorides. *Dose*, (rarely given) 10 min. to 1 fl.dr.

Liquor Sodæ is employed in preparing Sulphurated Antimony and Oxide of Bismuth.

From Liquor Sodæ are made:

a. **Soda Caustica.**—Caustic Soda. NaHO.

Source.—Made from Liquor Sodæ, like Potassa Caustica.

Characters.— Hard, greyish-white fragments, slightly deliquescent, very alkaline and corrosive. *Impurities.*—Same as of Liquor Sodæ.

β. **Sodii Valerianas.** See *Valerianæ Rhizoma.*

γ. **Sodii Bromidum.** — Bromide of Sodium. NaBr. See *Bromum*, page 129.

δ. **Sodii Iodidum.**—Iodide of Sodium. NaI. See *Iodum*, page 124.

d. **Soda Tartarata.** — Tartarated Soda. $NaKC_4H_4O_6,4H_2O$. Tartrate of Sodium and Potassium. Rochelle Salt.

Source.—Prepared by boiling Acid Tartrate of Potassium in a solution of Carbonate of Sodium, and crystallising. $Na_2CO_3 + 2KHC_4H_4O_6 = 2NaKC_4H_4O_6 + H_2O + CO_2$.

Characters.—Colourless, transparent, right rhombic prisms, tasting like common salt; neutral. *Solubility*, 1 in 2 of water. *Impurity.*—Acid Tartrate of Potassium. *Dose*, $\frac{1}{4}$ to $\frac{1}{2}$ oz. as a purgative; 30 to 60 gr. as a diuretic.

e. **Sodii Sulphas.**—Sulphate of Sodium. $Na_2SO_4,10H_2O$. Glauber's Salt.

Source.—Prepared by (2) adding Carbonate of Sodium to the acid residue left in (1) the manufacture of hydrochloric acid; and crystallising. (1) NaCl +

$H_2SO_4 = HCl + NaHSO_4$. (2) $Na_2CO_3 + 2NaHSO_4 = 2Na_2SO_4 + CO_2 + H_2O$.

Characters.—Colourless, transparent, oblique rhombic prisms, efflorescent, with a bitter salt taste. *Solubility*, 1 in 3 of water; insoluble in spirit. *Impurities.*—Salts of Ammonium and Iron. *Dose*, $\frac{1}{4}$ to 1 oz.

f. **Sodii Phosphas.**—Phosphate of Sodium. $Na_2HPO_4,12H_2O$.

Source.—Obtained by (2) adding a solution of Carbonate of Sodium to a solution of Acid Phosphate of Calcium, prepared from (1) a mixture of Bone-ash and Sulphuric Acid. (1) $Ca_32PO_4 + 2H_2SO_4 = CaH_42PO_4 + 2CaSO_4$. (2) $CaH_42PO_4 + Na_2CO_3 = Na_2HPO_4 + H_2O + CO_2 + CaHPO_4$.

Characters.—Colourless, transparent, rhombic prisms, efflorescent, tasting like common salt. *Solubility*, 1 in 5 of water. *Impurity.*—Phosphate of Lime.

Dose.—$\frac{1}{4}$ to 1 oz.

Sodii Phosphas is used to make Ferri Phosphas and Syrupus Ferri Phosphatis.

g. **Sodii Hypophosphis.**—$NaPH_2O_2$. See *Phosphorus*, page 104.

h. **Sodii Arsenias.**—$Na_2HAsO_4,12H_2O$; and $Na_2HAsO_4,7H_2O$. See *Arsenium*, page 107.

k. **Sodii Sulphis.**—$Na_2SO_3,7H_2O$. See *Acidum Sulphurosum*, page 147.

l. **Sodii Sulphocarbolas.**—$NaC_6H_5SO_4,2H_2O$. See *Acidum Carbolicum*, page 188.

m. **Sodii Salicylas.**—$(NaC_7H_5O_3)_2,H_2O$. See *Acidum Salicylicum*, page 365.

n. **Sodæ Chlorinatæ Liquor.** See *Chlorum*, page 121.

o. Acetate of Sodium. (*Appendix*, B.P.)

3. Sodii Nitras.—Nitrate of Sodium. $NaNO_3$.

Source.—Found native in Chili, and purified by crystallisation from water.

Characters.—Colourless, obtuse rhombohedral crystals, with a cooling saline taste. *Solubility*, 1 in 2 of water. *Impurities.*—Sulphates and chlorides.

Sodii Nitras is used in making Sodii Arsenias.

4. Borax.—Borax. Biborate of Sodium. $Na_2B_4O_7$, $10H_2O$. See *Acidum Boricum*, page 145.

GENERAL CHEMICAL CHARACTERS OF SODIUM SALTS.

Salts of Sodium (1) are characterised by their neutral solutions in water giving a precipitate with Met-antimoniate of Potassium. (2) They impart a yellow tinge to flame. (3) They are not volatile.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Soda possesses an action similar to that of Potash, but is much less frequently used as a **caustic.** The Ethylate is used to destroy small accessible tumours, such as nævi. Solutions of the Carbonates may be employed to neutralise caustic acids; in eczema and itching disorders of the skin; and in extensive burns. Sodium compounds with Olive Oil constitute Hard Soaps.

Internally.—Soda closely resembles Potash in its action on the alimentary canal, but is more powerful because much more slowly absorbed. Thus the Bicarbonate stimulates the flow of the gastric juice, and is more commonly given than the other alkalies, as a **stomachic**, in doses of gr. 8 to gr. 15, shortly before meals. Part of the salt at the same time becomes converted into the chloride, which assists the digestion of albumen. The alkali also liquefies tenacious mucus, and enables the gastric juice to reach the food more freely. Soda is also given after meals as an **antacid** to the contents of the stomach, relieving acidity due to indigestion, either as the Bicarbonate, Soda Water, or the official Lozenge, or in a mixture with Sal-volatile and an essential oil, such as Peppermint. Common Salt is a safe and available emetic.

The salts of Sodium being much less diffusible than those of Potassium, pass on into the small intestine. Here the Sulphate and Phosphate of Sodium, and Tartarated Soda (Rochelle salt) act as **saline purgatives.** The Sulphate, which is a constituent of several natural purgative waters, including Carlsbad, Marienbad, Friedrichshall, and Hunyàdi János, is the most powerful of these, producing an abundant watery evacuation. It is used as a hydragogue in dropsies, especially in ascites from liver disease; in congestion of the portal system; and as a habitual purgative. The Phosphate is a milder, but sufficiently active, purgative, less unpleasant to the palate; it is often given to children. Soda Tartarata, the purgative basis of the Seidlitz powder, is familiar as an intestinal stimulant, employed to complete the effect of purgative pills. The Chloride is an anthelmintic, generally administered in enema.

2. ACTION ON THE BLOOD, AND ITS USES.

The salts of Sodium are slowly absorbed into the blood, and slowly excreted from it, remaining in it chiefly as the Bicarbonate and Phosphate. Taken, as they constantly are, in food, these salts are the chief sources of the natural alkalinity of the liquor sanguinis, which may be increased by their medicinal exhibition as well as by the Citro-tartrate, Rochelle Salt, and Sulphate. This effect of Soda as an **alkaliser of the blood** is taken advantage of in the cases referred to under Potassium, namely, gout and rheumatism, only less frequently; for although Soda is less depressing, as we shall see, than Potash, and more easily borne by the stomach, the slowness of its entrance into the blood, and its tendency to pass off by the bowels when the dose is increased, more than counteract these advantages. When a prolonged and moderately alkaline influence is desired, especially in dyspepsia with a tendency to constipation, Soda is manifestly to be preferred.

3. SPECIFIC ACTION.

In medicinal doses, the salts of Sodium have **no specific influence** on any organ. This circumstance, which at first sight appears incredible, is due to the fact that the whole organism is saturated with Soda, which participates in many of the ordinary tissue changes; that Soda is admitted in large quantities by the food (especially vegetables and fruits); and that the moderate amount contained in medicinal doses does not appreciably affect metabolism. In this respect Soda differs remarkably from Potash, and it is therefore said to produce none of the depressing effects of that drug. As we have just seen, advantage is taken of this negative action of Soda in its other therapeutical applications.

4. REMOTE LOCAL ACTION AND USES.

Soda is excreted by all the mucous surfaces, by the kidneys, by the liver, and possibly by the skin; and in passing through the various epithelial structures it modifies the amount, composition, and reaction of their secretions. The action of the different salts naturally varies to a considerable extent, some affecting one organ more, some another.

1. *Alimentary Canal.*—The Sulphate and the Phosphate of Sodium are, as we have seen, hydragogue purgatives by virtue

of their *immediate* local action; but they are also stimulants of the intestinal glands, and are constantly being absorbed and excreted, re-absorbed and re-excreted, in their course along the bowel. (*See* page 462.) Both are also true **hepatic stimulants or direct cholagogues**; the Phosphate more so than the Sulphate. The value of these salts in hepatic and intestinal disorders, which has been already referred to, is therefore partly referable to their effect in increasing the bile. Soda Tartarata and Sodii Citro-tartras Effervescens have a similar but feebler action.

2. *Kidneys.*—Soda acts as a **diuretic**, but less powerfully than Potash, increasing the water and the solid constituents, and diminishing or neutralising the acidity of the urine. The Bicarbonate is the most useful salt of Sodium for this purpose; the Nitrate of Sodium, whilst also diuretic, is so inferior in this respect to the Nitrate of Potassium, that it is very seldom employed. The Tartarated Soda may be usefully combined with other **alkalisers of the urine**, as in the Seidlitz Powder; or the Effervescing Citro-tartrate may be given. The use of these alkalisers of the urine is explained under Potassium.

3. *Respiratory Passages.*—The bronchial mucous membrane becomes anæmic under the influence of large doses of Sodium salts, and its secretions diminished; but if the dose be moderate, the sputa become more abundant and liquid, and are more easily expelled by cough. The Bicarbonate and Chloride are therefore indicated in the early stages of bronchitis, when the mucous membrane is hyperæmic and swollen, and the cough harassing. The effects of Soda on the stomach, blood, and urine add much to its usefulness in such cases.

When a comprehensive view is taken of the action and uses of the salts of Sodium (locally in the alimentary canal, in the blood, in the tissues, and in the organs and passages where it is excreted from the body), it is found to be peculiarly indicated in a condition of system which may be called the "gouty," the "rheumatic," "acidity," or "chronic derangement of the liver," and which is specially characterised, amongst other symptoms, by catarrhs or discharges from the mucous membranes, interfering with the functions of the part; by imperfect biliary activity and constipation; and by scanty, high-coloured, very acid urine. In such a condition great benefit may be derived from a course of *alkaline waters*. If the stomach be the principal seat of catarrh, *i.e.* if chronic indigestion be urgent, the more purely *carbonated alkaline waters* should be selected, such as those of Vichy, Bilin, and

Ems. If the derangement chiefly involve the liver and intestines, the *sulphated and salt* (NaCl) *waters* will be more suitable, such as Carlsbad, Kissingen, Wiesbaden, and Marienbad. For chronic catarrh of the bladder and urinary passages, Ems, Vichy, Wildungen, and Carlsbad are indicated.

5. ACTION AND USES OF THE DIFFERENT SODIUM SALTS.

The action and uses of the preparations of Sodium may be summarised as follows, and the special action of some of the salts particularly noticed: *Soda Caustica* and *Liquor Sodæ* are for external use, but very rarely employed. *Sodii Carbonas* and *Bicarbonas* (the former rarely, the latter almost invariably used) possess the action and uses of Soda in general upon all parts. *Soda Tartarata* is like the Carbonates, but purgative; and more rapidly and distinctly diuretic and alkalising, by virtue of the Potassium it contains. *Sodii Citro-tartras* is like Tartarated Soda, but milder. *Sodii Nitras* is used pharmaceutically only. *Sodii Sulphas* and *Sodii Phosphas* are chiefly hydragogue purgatives and cholagogues, the former acting more on the bowels, the latter more on the liver. *Sodii Chloridum* is in large doses a free and safe emetic; an anthelmintic as enema; it possesses otherwise the ordinary action of Soda, and is greatly used for this purpose in the waters of Homburg, Wiesbaden, Kissingen and Baden-Baden, and as sea-water. The remaining salts of Sodium possess peculiar properties by virtue of their second constituent, and are described elsewhere: *Sodii Arsenias* under Arsenium; *Sodii Bromidum* under Bromum; *Sodæ Chlorinatæ Liquor* under Chlorum; *Sodii Hypophosphis* under Phosphorus; *Sodii Iodidum* under Iodum; *Borax* under Acidum Boricum; *Sodii Salicylas* under Acidum Salicylicum; *Sodii Sulphis* under Acidum Sulphurosum; *Sodii Valerianas* under Valerianæ Rhizoma.

AMMONIUM. NH_4. 18.

All the official salts and preparations of Ammonium are derived directly or indirectly from the Chloride, that is, ultimately from Ammoniacal Gas Liquor.

Ammonii Chloridum.—Chloride of Ammonium, Sal Ammoniac. NH_4Cl.

Source.—Made by neutralising Ammoniacal Gas Liquor with Hydrochloric Acid; evaporating to dryness; and purifying by sublimation. $NH_4HO + HCl = NH_4Cl + H_2O$.

Characters.—Colourless crystals; or translucent, fibrous masses; inodorous. *Solubility*, 1 in 4 of water; soluble in rectified spirit; volatilises with heat. *Impurities.*—Iron and lead, tarry matter, and chlorides of compound ammoniums.

Dose.—5 to 20 gr.

From Ammonii Chloridum are made:

1. **Liquor Ammoniæ Fortior.**—Strong Solution of Ammonia. NH_3 (32·5 per cent.) dissolved in Water.

Source.—Made by heating Chloride of Ammonium with Slaked Lime, and collecting the gaseous product in water. $2NH_4Cl + Ca(HO)_2 = 2NH_3 + CaCl_2 + 2H_2O$.

Characters.—A colourless liquid with a very pungent characteristic odour, and strong alkaline reaction; Sp. gr. 0·891. *Impurities.*—Ammonium chloride, sulphide, and sulphate; lime; and metals.

From Liquor Ammoniæ Fortior are made:

a. **Ammonii Phosphas.**—Phosphate of Ammonium. $(NH_4)_2HPO_4$.

Source.—Made by adding Strong Solution of Ammonia to Diluted Phosphoric Acid (keeping the alkali in excess); evaporating; and crystallising. $H_3PO_4 + 2NH_4HO = (NH_4)_2HPO_4 + 2H_2O$.

Characters.—Transparent colourless prisms, becoming opaque by exposure. *Solubility*, 1 in 2 of water; insoluble in spirit. *Dose*, 5 to 20 gr.

b. **Linimentum Camphoræ Compositum.**—Compound Liniment of Camphor. Strong Solution of Ammonia, 40; Camphor, 20; Rectified Spirit, 120; Oil of Lavender, 1. Mix and shake until the solution is clear. 1 in 4½.

c. **Liquor Ammonii Citratis Fortior.**

Source.—Made by neutralising 12 oz. of Citric Acid with 11 fl.oz. of Strong Solution of Ammonia. $H_3C_6H_5O_7 + 3NH_4HO = (NH_4)_3C_6H_5O_7 + 3H_2O$. *Dose*, ½ to 1½ fl.dr.

From Liquor Ammonii Citratis Fortior is made:

Liquor Ammonii Citratis.—Strong Solution of Citrate of Ammonium $(NH_4)_3C_6H_5O_7$, 1 part, dissolved in Water 4 parts. *Dose*, 2 to 6 fl.dr.

d. **Spiritus Ammoniæ Aromaticus.**—Aromatic Spirit of Ammonia. Sal Volatile. Carbonate of Ammonium, 4 oz.; Strong Solution of Ammonia, 8 fl.oz.; Volatile Oil of Nutmeg, 4½ fl.dr.; Oil of

Lemon, 6½ fl.dr.; Rectified Spirit, 6 pints; Water, 3 pints. Distil the oils and spirit; dissolve the Ammonia and Carbonate of Ammonium in a small part of the distillate with the aid of heat; and add the rest to make a gallon. Sp. gr. 0·896. *Dose,* ½ to 1 fl.dr.

Spiritus Ammoniæ Aromaticus is used in making:

Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata.

e. **Spiritus Ammoniæ Fœtidus.**—Fœtid Spirit of Ammonia. Made by adding Strong Solution of Ammonia to an extract made from Asafœtida by maceration in Spirit. *Dose,* ½ to 1 fl.dr.

f. Tinctura Opii Ammoniata. (See *Opium,* page 112.)

g. **Liquor Ammoniæ.**—Solution of Ammonia. NH_3 (10 per cent.) dissolved in water. Strong Solution of Ammonia, 1; Distilled Water, 2. Sp. gr. 0·959. *Dose,* 10 to 20 min., well diluted.

Preparation.

LINIMENTUM AMMONIÆ. — Liniment of Ammonia. Solution of Ammonia, 1; Olive Oil, 3.

From Liquor Ammoniæ are made:

α. **Ammonii Benzoas.**—Benzoate of Ammonium. $NH_4C_7H_5O_2$. See *Benzoinum,* page 313.

β. **Ammonii Bromidum.**—Bromide of Ammonium. NH_4Br. See *Bromum,* page 129.

γ. **Ammonii Nitras.**—Nitrate of Ammonium. NH_4NO_3.

Source.—Made by neutralising Diluted Nitric Acid with Solution of Ammonia (or Carbonate of Ammonium), crystallising, and fusing at 320° Fah., until the vapour of water is no longer emitted.

Characters.—A white deliquescent salt, in confused crystalline masses, with a bitter acrid taste; neutral. *Solubility,* 4 in 3 of water;

1 in 11 of spirit. Used only for making Nitrous Oxide Gas (N_2O). (*See* page 171.)

Solution of Ammonia is also used in preparing:
Tinctura Quininæ Ammoniata.

2. **Ammonii Carbonas.**—Carbonate of Ammonium. $N_3H_{11}C_2O_5$.

Source.—Made by subliming a mixture of Chloride of Ammonium (or Sulphate of Ammonium) and Carbonate of Calcium. (1) $2NH_4Cl + CaCO_3 = (NH_4)_2CO_3 + CaCl_2$. (2) $2(NH_4)_2CO_3 = NH_4HCO_3 + NH_4NH_2CO_2 + NH_3 + H_2O$. (3) $NH_4HCO_3 + NH_4NH_2CO_2 = N_3H_{11}C_2O_5$. This salt is considered to be a compound of Acid Carbonate of Ammonium (NH_4HCO_3) with Carbamate of Ammonium ($NH_4NH_2CO_2$); and the compound molecule is usually regarded as containing one molecule of each of these salts.

Characters.—Translucent crystalline masses, volatile and pungent to the nose. *Solubility*, 1 in 4 of water. 20 gr. neutralise $26\frac{3}{4}$ gr. Citric Acid, or $28\frac{3}{4}$ gr. Tartaric Acid. *Impurities.*—Sulphates and chlorides.

Dose.—3 to 10 gr. as a stimulant or expectorant; 30 gr. as an emetic.

From Ammonii Carbonas are made:

a. Spiritus Ammoniæ Aromaticus.

b. **Liquor Ammonii Acetatis Fortior.**—Strong Solution of Acetate of Ammonium, $(NH_4)C_2H_3O_2$.

Source.—Made by neutralising Carbonate of Ammonium by Acetic Acid, and adding water. $NH_4HCO_3,NH_4NH_2CO_2 + 3HC_2H_3O_2 = 3(NH_4)C_2H_3O_2 + H_2O + 2CO_2$. Sp. gr. 1·073. *Dose,* 25 to 75 min.

From Liquor Ammonii Acetatis Fortior is made:

Liquor Ammonii Acetatis.—Mindererus' Spirit. Strong Solution of Acetate of Ammonium, 1; Water, 5. *Dose,* 2 to 6 fl.dr.

Ammonii Chloridum is used in making:
Liquor Hydrargyri Perchloridi.

GENERAL CHEMICAL CHARACTERS OF AMMONIUM SALTS.

Salts of Ammonium are soluble and colourless; and are easily decomposed and give up Ammonia on being mixed with a caustic alkali or lime.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, Ammonia is a **stimulant** to the nerves and other structures, causing a sensation of pain and burning, and reddening the part by dilating the vessels. If the application be prolonged and the vapour confined, blistering may result; but dilute preparations produce only a **rubefacient** effect and a sense of heat. It is used in the form of Linimentum Ammoniæ, or Linimentum Camphoræ Compositum, to stimulate the circulation in a part, either for the purpose of increasing the local nutrition, for instance, in stiffness or other chronic conditions of joints, or as a **counter-irritant** (*see* page 564) in diseases of deeper parts, *e.g.* on the surface of the chest in bronchitis. Ammonia is not to be used as a caustic; and vesication by it is better avoided. In serpent's bite, the application of Ammonia to the wound has occasionally saved life.

Internally.—Admitted into the *nose*, Ammonia itself, or the vapour of the Carbonate ("smelling salts"), is a powerful **general stimulant,** instantly causing a pungent sensation, sneezing, and other disturbances of respiration, acceleration of the pulse, and watery secretion from the parts, including the conjunctiva. It is accordingly used as a means of resuscitating consciousness, the action of the heart, and respiration, in cases of failure of the circulation (such as fainting), or asphyxia from any cause (drowning, hanging, or poisoning by narcotics).

In the *stomach*, Ammonia produces the same effects as on the skin. A full dose (30 gr. of the Carbonate well diluted) is an emetic, which is best used in croup and bronchitis. Smaller doses cause a sense of warmth at the epigastrium, and act as **carminatives and reflex general stimulants**, Sal Volatile being chiefly used for this purpose. In common with Soda and Potash, it has an **antacid** effect on the contents of the stomach, and may be given after meals in dyspepsia. Like these, also, it acts as a natural stimulant to the gastric juice before meals, and Sal Volatile is therefore a common ingredient of **alkaline stomachic** mixtures. On the bowels, Ammonia, in medicinal doses, appears to have no immediate local action.

2. ACTION ON THE BLOOD, AND ITS USES.

Ammonia is absorbed into the blood, and is there fixed; increasing, possibly, the alkalinity of the plasma, and diminishing the tendency to coagulation. The Phosphate is believed to be useful in gout, by keeping uric acid in solution.

3. SPECIFIC ACTION AND USES.

Ammonia stimulates the central nervous system generally, especially the cord and the respiratory centre, whilst the frequency of the heart and the blood pressure are both increased: it is thus a **general stimulant.** It is much given in exhausted states of the vital powers, especially if respiration and circulation threaten to fail, as in typhoid fever complicated with pneumonia; in the bronchitis of old or weakly subjects; and in ordinary acute pneumonia with increasing feebleness of the heart. In serpent's bite, it is given internally in water, or hypodermically (10 to 20 minims diluted) whilst it is applied to the wound. The Chloride is a direct cholagogue. Salts of Ammonium decidedly increase the production of urea, partly, at least, by their own decomposition with Carbonic Acid in the liver: (1) $2NH_3 + CO_2 = NH_4NH_2CO_2$ (Ammonium Carbamate). (2) $NH_4NH_2CO_2 = CO(NH_2)_2$ (Urea) $+ H_2O$.

4. REMOTE LOCAL ACTION AND USES.

Ammonia is excreted by the kidneys and mucous membranes, especially the respiratory tract; not, however, as Ammonia, but as some other nitrogen compound, possibly urea or uric acid. Thus, instead of diminishing, it actually **increases the acidity of the urine,** whilst the amount of urea and uric acid also rises, as well as the volume of the secretion. The Chloride of Ammonium possesses these important powers most fully, the Acetate less fully; they may be employed as **diuretics** in dropsies and fever.

The *bronchial* secretion is distinctly increased, and rendered more liquid and easily raised, by the Carbonate and Chloride of Ammonium. These salts prove of great service as **expectorants** in the treatment of bronchitis when the secretion is scanty and thick, or the patient feeble; the accompanying stimulation of the respiratory centre increasing the coughing or expectorant power, whilst the heart is also strengthened.

The mucous secretion of the *stomach* is affected by Ammonia as by the other alkalies, and the Chloride is sometimes used in Chronic Dyspepsia. Ammonia remotely stimulates the *intestines,* and will cause diarrhœa if given in large doses.

On the *skin* the Acetate of Ammonium acts as a well-marked remote stimulant, Liquor Ammonii Acetatis being one of our most common **diaphoretics.** The Chloride also possesses the same property, but to a less degree.

5. ACTION AND USES OF THE DIFFERENT SALTS OF AMMONIUM.

These may be thus summarised: *Liquor Ammoniæ Fortior* and *Liquor Ammoniæ* are used as local and general stimulants, the former externally only. *Ammonii Carbonas,* a volatile stimulant, emetic, and double expectorant (through the nerves and secretions). *Ammonii Chloridum,* a local refrigerant, its solution producing cold; a gastric, intestinal, and hepatic stimulant; nervous stimulant; diuretic, double expectorant, and diaphoretic (hence called an "alterative"). *Liquor Ammonii Acetatis,* diaphoretic and diuretic (febrifuge), and nervous stimulant. *Liquor Ammonii Citratis,* diuretic and diaphoretic. *Spiritus Ammoniæ Aromaticus,* agreeable and powerful carminative, antacid, and general stimulant. *Ammonii Phosphas,* direct cholagogue, possibly an alkaliser of the blood, a nervine stimulant. *Spiritus Ammoniæ Fœtidus.* (See *Asafœtida.*) *Ammonii Benzoas.* (See *Benzoinum.*) *Ammonii Bromidum.* (See *Bromum.*)

LITHIUM. LITHIUM. L. 7.

This metal is obtained from several minerals, such as Petalite and Lepidolite; and traces of it occur in certain mineral waters, *e.g.* Baden-Baden, Carlsbad, and Vals. Only two of its salts are official.

Lithii Carbonas.—Carbonate of Lithium. L_2CO_3.
Source.—Made by the action of Carbonate of Ammonium on Chloride of Lithium, obtained from minerals.

Characters.—A white powder, or minute crystalline grains; alkaline. *Impurities.*—Lime, Alumina, detected by lime-water; deficiency of Lithia, detected by weight of residue. *Solubility,* 1 in 150 of water; insoluble in alcohol.

Dose.—3 to 6 gr., in 3 or 4 oz. of aërated water.

Preparation.

LIQUOR LITHIÆ EFFERVESCENS.—Effervescing Solution of Lithia. Lithia Water. Made like Potash Water. 10 gr. to 1 pint. *Dose,* 5 to 10 fl.oz.

From Lithii Carbonas is made:

Lithii Citras.—Citrate of Lithium. $L_3C_6H_5O_7, 4H_2O$.

Source.—Made by dissolving Carbonate of Lithium in a solution of Citric Acid, evaporating, and crystallising. $3L_2CO_3 + 2H_3C_6H_5O_7 = 2L_3C_6H_5O_7 + 3H_2O + 3CO_2$.

Characters.—A white crystalline salt. *Solubility,* 1 in 2½ of water. *Dose,* 5 to 10 gr.

GENERAL CHEMICAL CHARACTERS OF LITHIUM SALTS.

They impart a rich crimson colour to flame; give a white precipitate with Na_2CO_3 after long standing; and the Hydrate, Carbonate, and Phosphate are only slightly soluble in water.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally.—Lithia may be used as a fomentation in gout.

Internally.—Lithium has doubtless an **antacid** action on the alimentary canal, very similar to that of Potassium. The Carbonate is apt to cause indigestion unless given in very weak solutions.

·2. ACTION ON THE BLOOD, AND ITS USES.

Lithium quickly enters the blood, and behaves there much like Potassium, **increasing its alkalinity**, and combining with uric acid, for which it has a powerful affinity. It is extensively used in gout, to hold this substance in solution, and thus to prevent acute attacks by fresh deposit in the tissues.

3. SPECIFIC ACTION AND USES.

In this respect also Lithium closely resembles Potassium, being a cardiac and nervo-muscular **depressant** if given in large doses or for a length of time. It may possibly dissolve gouty deposits (urates) in joints.

4. REMOTE LOCAL ACTION AND USES.

Lithium is rapidly excreted by the kidneys, and probably by the mucous membranes. It is a powerful **diuretic**, and whilst increasing the volume of water, **diminishes its acidity**, and holds in solution even an excess of uric acid. For this reason, also, it is a valuable remedy in gout, as it hastens the excretion of the products which it dissolves in the blood, and in acid lithiasis or gravel, where it prevents the deposit of salts in the kidney and urinary passages.

Both salts of Lithium may be used, the important difference between them being with respect to their solubility, which is very marked.

CALCIUM. CALCIUM. Ca. 40.

There are four great sources of the official salts and preparations of Calcium, namely, (1) Chalk, (2) Marble, (3) Native Sulphate, and (4) Bone-ash.

1. Creta.—Chalk. Native friable Carbonate of Calcium.

From Creta are made:

a. **Creta Præparata.**—Prepared Chalk. $CaCO_3$ (nearly pure).

Source.—Made from Chalk by elutriation and drying.

Characters.—A white amorphous powder, in small cones, insoluble in water; *incompatible* with all acids and sulphates. *Dose,* 10 to 60 gr.

Preparations.

α. **Mistura Cretæ.** — Chalk Mixture. Prepared Chalk, 1; Gum Acacia, 1; Syrup, 2; Cinnamon Water, 30. *Dose,* 1 to 2 fl.oz.

β. **Pulvis Cretæ Aromaticus.** — Aromatic Powder of Chalk. Prepared Chalk, 11; Cinnamon, 4; Nutmeg, 3; Saffron, 3; Cloves, 1½; Cardamom Seeds, 1; Sugar, 25. *Dose,* 10 to 60 gr.

From Pulvis Cretæ Aromaticus is made:

PULVIS CRETÆ AROMATICUS CUM OPIO.—Aromatic Powder of Chalk and Opium. Aromatic Chalk Powder, 39; Opium, 1. *Dose,* 10 to 40 gr.

γ. HYDRARGYRUM CUM CRETÂ. — See *Hydrargyrum.*

b. **Calx.**—Lime. CaO (with some impurities).

Source.—Calcining Chalk. $CaCO_3 = CaO + CO_2$.

Characters.—Compact whitish masses, which readily absorb water, crack, evolve great heat, and fall into powder (slaking).

From Calx is made:

Calcii Hydras.—Hydrate of Calcium. Slaked Lime. $Ca(HO)_2$ (with some impurities).

Source.—Made by slaking Lime with Distilled Water. $CaO + H_2O = Ca(HO)_2$.

Characters.—A white powder, strongly alkaline; more soluble in *cold* water (1 in 900), and with sugar (1 in 60). *Incompatible* with vegetable and mineral acids, alkaline and metallic salts, and tartar emetic.

From Calcii Hydras are made:

i. **Liquor Calcis.**—Solution of Lime. Lime-Water. Made by shaking up Slaked Lime (previously washed in water, to free it from chlorides) in Distilled Water, and decanting. ½ gr. of Lime in 1 fl.oz. *Dose*, ½ to 4 fl.oz.

Preparations.

LINIMENTUM CALCIS. — Solution of Lime and Olive Oil, equal parts mixed.

Liquor Calcis is also used in preparing:

Lotio Hydrargyri Flava, Lotio Hydrargyri Nigra, and Argenti Oxidum.

ii. **Liquor Calcis Saccharatus.**—Saccharated Solution of Lime. Made by digesting Slaked Lime and Sugar in Water; and decanting. 7·11 grains of lime in 1 fl.oz. *Dose*, 15 to 60 min.

iii. **Calx Chlorinata.** — See *Chlorum*, page 120.

iv. **Calcii Hypophosphis.**—See *Phosphorus*, page 104.

c. **Calcii Chloridum.**—Chloride of Calcium. $CaCl_2, 2H_2O$.

Source.—Made by neutralising Hydrochloric Acid with Chalk, adding a little Solution of Chlorinated Lime and Slaked Lime, to remove iron; filtering; and evaporating to dryness. $CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$.

Characters.—White, very deliquescent masses, with bitter acrid taste. *Solubility*, 1 in 2 of water. *Impurities.*—Carbonates; salts of aluminium and iron; hypochlorites, detected by evolving Cl with HCl. *Dose*, 3 to 10 gr.

Preparation.

a. LIQUOR CALCII CHLORIDI.—Chloride of Calcium, 1; Water, 3. *Dose*, 15 to 50 min.

Calcii Chloridum is used to make :

β. **Calcii Carbonas Præcipitata.**—Precipitated Carbonate of Calcium. Precipitated Chalk. $CaCO_3$.

Source.—Made by mixing boiling solutions of Chloride of Calcium and Carbonate of Sodium; and washing and drying the precipitate. $CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$.

Characters.—A white crystalline powder, insoluble in water. *Impurities.*—Chlorides, alumina, and iron. *Dose*, 10 to 60 gr.

Calcii Carbonas Præcipitata is contained in : Trochisci Bismuthi (4 gr. in each).

2. Marmor Album.—White Marble. $CaCO_3$. *Characters.*—Hard, white, crystalline masses. Used in producing Carbonic Acid Gas.

3. Calcii Sulphas.—Sulphate of Calcium. "Plaster of Paris." Native Sulphate of Calcium ($CaSO_4,2H_2O$) rendered nearly anhydrous by heat.

Calcii Sulphas is used to make :

Calx Sulphurata.—See *Sulphur*, page 134.

4. Calcii Phosphas. — Phosphate of Calcium. Ca_32PO_4.

Source.—Made by (1) dissolving Bone-ash in Hydrochloric Acid and Water; (2) adding Water and Solution of Ammonia to alkalinity; and washing and drying tho precipitate. (1) $Ca_32PO_4 + 4HCl = CaH_42PO_4 + 2CaCl_2$; (2) $CaH_42PO_4 + 2CaCl_2 + 4NH_4HO = Ca_32PO_4 + 4NH_4Cl + 4H_2O$.

Characters.—A light white amorphous powder, insoluble in water. *Dose*, 10 to 20 gr.

Calcii Phosphas is contained in Pulvis Antimonialis.

GENERAL CHEMICAL CHARACTERS OF CALCIUM SALTS.

Calcium gives a red colour to flame. Solutions of Calcium salts give a white precipitate with Ammonium Oxalate, insoluble in Acetic Acid; not with Sulphide of Ammonium.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Lime in tho form of the Hydrate is **caustic**, like the alkalies, but its action is more localised, so that it may be combined with Fused Potash to form a convenient caustic, *Potassa cum Calce*, Vienna Paste, for ordinary use. Dusted on the skin as Chalk, or applied as Lime-Water, it is **astringent and desiccative** (drying), and is used to promote the healing of burns, eczema, and ulcers. The Linimentum Calcis is a valuable application to burns, and in extensive eczema.

Internally, the local effect of lime is **antacid**, like the alkalies and Magnesia, combined with an astringency peculiar to itself. In the mouth, Chalk is used as an antacid and physical dentifrice. Admitted into the stomach and intestines, as Lime-Water or the Carbonate, Lime (1) unites with the *free acids* of the contents. Lime-water prevents the gastric juice from curdling milk in large lumps, and is extensively given to artificially-reared infants, the Liquor Calcis Saccharatus being an excellent form when dilution of the food is injurious. Lime is a valuable **antidote** for poisoning by the mineral acids, oxalic acid, and chloride of zinc, and one which is always available in the form of wall-plaster; it must be freely given. Acid dyspepsia, with heart-burn, may sometimes be relieved by Lime-Water or the Bismuth Lozenge, given after food. (2) On the *glands* of the stomach the action of Lime appears to be depressant, and it is, therefore, not suited for administration before meals. Lime-water is, indeed, a general **gastric sedative** of some value, arresting some kinds of vomiting, especially in the acid dyspepsia of infants, and in pregnancy.

The Calcium salts can be traced along the whole length of the canal, and most of their bulk is finally expelled unabsorbed. Their **astringent** action in diarrhœa may be in part due to their antacid property; in part referable to an obscure sedative effect on the intestinal glands (? and vessels), which diminishes the excretion of water in the bowel; and in part physical. Lime and Chalk thus come to be two of our most valuable drugs in diarrhœa, either alone or with Aromatics, Opium, or vegetable astringents, as in the official preparations.

Lime-water is also employed locally as an enema for killing the thread-worm, and as a vaginal injection in leucorrhœa.

2. ACTION ON THE BLOOD, AND ITS USES.

Lime enters the circulation in very small quantities only, and appears in the plasma as the phosphate. It probably somewhat increases the alkalinity of the blood, whence part of the value of the Calcareous Waters of Bath and other spas, in gout and rheumatism.

3. SPECIFIC ACTION AND USES.

The important part played by Calcium as a constituent of bones has suggested its use as a specific remedy in rickets, fractures, and other lesions of these structures; and the Phosphate and Lime-Water are extensively used for the two former conditions. The Phosphate and the Chloride have been recommended in scrofulous diseases of glands and phthisis, to promote absorption, or possibly induce calcification; and apparently with some reason. Some of the calcareous mineral waters appear to be of service in this respect.

4. REMOTE LOCAL ACTION AND USES.

The greater part of Calcium or its salts being expelled by the bowel, little remains to be excreted by the kidneys. An alkalising effect on the urine can scarcely be appreciated, but they are certainly **diuretic** in the form of the waters of Bath and Wildungen, which are ordered in gout and gravel.

5. ACTION AND USES OF THE DIFFERENT SALTS OF CALCIUM.

Creta in its various forms and combinations, *Calcii Carbonas Præcipitata*, *Liquor Calcis*, and *Liquor Calcis Saccharatus*, possess the general actions and uses of Lime. *Calcii Chloridum* has been highly recommended as a specific in scrofulous enlargement of glands; and is used in testing. *Calcii Phosphas* is a specific in bone diseases and scrofula. *Calx Chlorinata* and its derivates are media for supplying chlorine, and used accordingly. (*See* page 121.) *Calcii Hypophosphis* is employed as a specific in tuberculosis and other wasting diseases (page 106). In the remaining preparations the action of the Lime or Chalk is comparatively insignificant, as in the three preparations of Mercury of which they are ingredients, and in Antimonial Powder. Calcii Sulphas is used for surgical and pharmaceutical purposes. Calx Sulphurata is used in suppuration, in boils, and in scrofulous sores (page 136).

MAGNESIUM. MAGNESIUM. Mg. 24.

All the official salts and preparations of Magnesium are derived directly or indirectly from the Sulphate:

'**Magnesii Sulphas.** — Sulphate of Magnesium. Epsom Salt. $MgSO_4,7H_2O$.

Source.—Made from Magnesian Limestone (dolomite), by solution in Sulphuric Acid, and purification.

Characters.—Minute colourless rhombic prisms, with a bitter taste. *Solubility*, 10 in 13 of cold water. *Incompatible* with alkaline carbonates, lime-water, acetate of lead, and nitrate of silver. *Impurities.*—Lime, iron, and general impurities. *Dose*, 60 gr. to ½ oz.

Preparations.

a. ENEMA MAGNESII SULPHATIS.—1 oz. to 15 fl.oz. of Mucilage of Starch, with 1 fl.oz. of Olive Oil.

b. MISTURA SENNÆ COMPOSITA.—1 oz. in 5 fl.oz. See *Senna*, page 261.

From Magnesii Sulphas are made :

c. **Magnesii Carbonas Ponderosa.**—Heavy Carbonate of Magnesium. $(MgCO_3)_3,Mg(HO)_2,4H_2O$.

Source.—Made by mixing *strong boiling* solutions of Sulphate of Magnesium and Carbonate of Sodium, evaporating, purifying, and drying. $4MgSO_4 + 4Na_2CO_3 + H_2O = 3(MgCO_3),Mg(HO)_2 + 4Na_2SO_4 + CO_2$.

Characters.—A white granular powder, comparatively insoluble in water. *Incompatible* with acids. *Impurities.*—Lime, Sulphates. *Dose*, 10 to 60 gr.

Preparations.

α. LIQUOR MAGNESII CARBONATIS. — "Fluid Magnesia." The Carbonate in solution.

Source.—Made by passing an excess of Carbonic Acid gas under pressure of three atmospheres through Carbonate of Magnesium (freshly prepared from $MgSO_4$ and Na_2CO_3) and Water.

Characters.—A clear effervescing fluid. Contains nearly 10 gr. of the Carbonate in 1 fl.oz. *Dose*, 1 to 2 fl.oz.

β. LIQUOR MAGNESII CITRATIS. Solution of Citrate of Magnesium, $Mg_3 2C_6H_5O_7,14H_2O$.

Source.—To a solution of Carbonate of Magnesium, Citric Acid, and Syrup of Lemons in a strong bottle, add Bicarbonate of Potassium ; wire down, and shake.

Characters.—A clear effervescing fluid. *Dose*, 1 to 2 fl.oz.

γ. Trochisci Bismuthi.—2½ gr. in each.

From Magnesii Carbonas Ponderosa is made :

Magnesia Ponderosa.—Heavy Magnesia. MgO.

Source.—Made by heating the Heavy Carbonate in a crucible to expel the CO_2.

Characters.—A white powder, comparatively insoluble in water (1 in 5,412 cold water, 1 in 36,000 hot water). *Incompatible* with acids. *Impurities.*—Those of the Carbonate. *Dose,* 10 to 60 gr.

d. **Magnesii Carbonas Levis.**—Light Carbonate of Magnesium. $(MgCO_3)_3Mg(HO)_2,4H_2O$.

Source.—Made like Magnesii Carbonas Ponderosa, but with *cold dilute* solutions; boiling for 15 minutes; washing and drying.

Characters.—A very light white powder, proving microscopically to be partly amorphous, with prismatic crystals. Soluble in 2,493 parts of cold water; in 9,000 parts of hot water. 3½ times the bulk of the Heavy Carbonate. *Dose,* 10 to 60 gr.

Magnesii Carbonas Levis is used in preparing Vapor Olei Pini Sylvestris.

From Magnesii Carbonas Levis is made:

Magnesia Levis.—Light Magnesia. MgO.

Source.—Made by heating Light Carbonate of Magnesium in a crucible to expel the CO_2.

Characters.—A white, very light powder, 3½ times the bulk of Heavy Magnesia; sparingly soluble in water. *Dose,* 10 to 60 gr.

Magnesia Levis or Ponderosa is contained in Pulvis Rhei Compositus (6 parts in 9).

GENERAL CHEMICAL CHARACTERS OF MAGNESIUM SALTS.

The soluble salts of Magnesium give a white precipitate with Ammonia and Sodium Phosphate.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Magnesium has no action, and is not used.

Internally, Magnesium is a valuable means of decomposing the contents of the stomach and intestines under various circumstances:

(1) The Oxide and Carbonates form comparatively insoluble or innocuous compounds with the mineral acids, oxalic acid, and mercuric, arsenical, and cupric salts; in large quantities they prevent the absorption of alkaloids by rendering the contents of the stomach alkaline; whilst the Sulphate precipitates insoluble sulphates of lead and barium. Magnesia

or its salts may therefore be employed as **antidotes** in cases of poisoning by any of these substances, the Oxide being preferred to the Carbonate, so as to prevent the evolution of carbonic acid, and care being taken to give it very freely.

(2) By a similar process of decomposition, Magnesia **neutralises** normal or excessive **acidity** in the stomach and bowels, and is itself converted into the chloride, lactate, and bicarbonate, this reaction removing irritant acid, and forming salts of Magnesium which have a stimulant or purgative action on the intestine. The Carbonate yields carbonic acid, which exerts its specific action on the stomach. Both substances are therefore employed as local **alkaline remedies** in acidity of the stomach (heart-burn, pyrosis, etc), given with Sal-Volatile, between meals, when a further laxative effect is desired.

The chloride, bicarbonate, or lactate formed in the stomach, or the Sulphate of Magnesium directly given, having reached the intestine, are very slowly absorbed, and if in sufficient quantity, produce very marked local effects as **saline purgatives**, the Sulphate being hydragogue in its action, with little stimulation of the muscular coat. The result is the free evacuation of a quantity of water by the bowel, and with it almost the whole of the Magnesium. Sulphate of Magnesium (Epsom Salt) is our most common saline purgative, in the form of Mistura Sennæ Composita; of a simple solution in Acid Infusion of Roses, with some carminative; and of several of the popular aperient waters, such as Friedrichshall, Püllna, Hunyàdi János, of all of which it is an important constituent. Sulphate of Magnesium is a mild, painless, non-nauseating purgative, less rapid in its action than the Sodium salt; and may be used to complete the effect of purgative pills in portal congestion, in chronic constipation as an habitual laxative combined with other salts in the above-named waters, and in feverish attacks with loaded bowels. It is also given as the Enema.

Magnesia and the Carbonates, when used as purgatives, are chiefly given to children in diarrhœa with foul acid stools, very frequently as Pulvis Rhei Compositus (Gregory's Powder).

In small doses neither salt has any purgative action on the bowel, but enters the blood.

2. ACTION ON THE BLOOD, AND ITS USES.

Entering the circulation as the chloride or lactate, Magnesia **increases the alkalinity of the plasma**, of which it is a normal constituent, and helps to hold in solution any acid which may be in excess. It will therefore be useful in chronic gout and rheumatism, to assist the more powerful alkalisers of the blood with which it is combined in the waters of Ems, Baden-Baden, Aix-les-Bains, Carlsbad, etc.

3. SPECIFIC ACTION.

Magnesia taken medicinally does not exert any appreciable effect upon the tissues or nutrition generally. Although an important constituent of bone, it cannot be said to be of any value in rickets or other diseases in which the osseous tissue is deficient in solid matter.

4. REMOTE LOCAL ACTION AND USES.

When Magnesia does not purge, it is excreted chiefly by the kidneys, rendering the urine more abundant and less acid, and dissolving uric acid. Its **diuretic** effect contributes to the value of Magnesia waters in gout and gravel.

BARIUM. BARIUM. Ba. 137.

This metal is introduced into the Appendix of the Pharmacopœia for testing purposes only, but may also be given medicinally.

Chloride of Barium. $BaCl_2,2H_2O$.
Characters.—Colourless translucent tables. *Dose,* ½ to 2 gr.

SOLUTION OF CHLORIDE OF BARIUM, 1 in 10.

GENERAL CHEMICAL CHARACTERS OF BARIUM SALTS.

Salts of Barium give an insoluble white precipitate with Sulphuric Acid, or any sulphate.

ACTION AND USES.

In the lower animals the Salts of Barium greatly **disturb the blood pressure**, first increasing it apparently through the heart, which is arrested in systole, and greatly lowering it before death. The Chloride has accordingly been recommended in aneurysm. In animals, Barium also affects the central nervous system, and through it the muscles of the bowels, bladder, vessels, and limbs, causing purgation, urination, spasms, and convulsions ending in paralysis. The empirical use formerly made of the metal in chronic nervous diseases and in glandular enlargements may possibly be explained by these effects.

CERIUM. CERIUM. Ce. 92.

Only one salt of this metal is official.

Cerii Oxalas.—Oxalate of Cerium. $CeC_2O_4,3H_2O$.

Source.—Made by precipitating a solution of Oxalate of Ammonium with a soluble salt of Cerium.

Characters.—A white granular powder; insoluble in water. *Impurities.*—Alumina; detected by its solution in potash giving precipitate with NH_4Cl. Other oxalates (*e.g.* of lanthanum and didymium), the ash of which effervesces with boiling HCl.

Dose.—1 to 2 gr., or more.

ACTION AND USES.

Nothing is definitely known about the physiological action of Cerium. It is given with benefit in **vomiting**, acid dyspepsia, and heart-burn, especially when they occur in pregnancy; and has been credited with good effects in chronic nervous diseases, such as epilepsy and chorea.

GROUP II.

THE METALS.

The metallic elements officially recognised fall naturally into several Sub-Groups, according to their action and uses: 1. Plumbum, Argentum, Zincum, Cuprum, and Aluminium. 2. Ferrum and Manganesium. 3. Hydrargyrum. 4. Phosphorus, Arsenium, Antimonium, and Bismuthum. Phosphorus, although a non-metallic element, is included here, because very closely allied pharmacologically with Antimony and Arsenic.

SUB-GROUP 1.

PLUMBUM, ARGENTUM, ZINCUM, CUPRUM, ALUMINIUM.

PLUMBUM. LEAD. Pb. 207.

There are three official sources of the salts and preparations of Lead contained in the Pharmacopœia, namely: (1) the Oxide, (2) the Carbonate, and (3) the Nitrate.

1. Plumbi Oxidum.—Oxide of Lead. Litharge. PbO.

Source.—Made by roasting lead in a current of air. $Pb + O = PbO$.

Characters.—Heavy scales of a pale brick red colour. Soluble in nitric and acetic acids; insoluble in water. *Impurities.*—Copper, iron, and carbonates.

Preparations.

EMPLASTRUM PLUMBI.—Lead Plaster; Lead Soap; Oleate of Lead. 1 of Oxide boiled in 2 of Olive Oil and 1 of Water. $3PbO + 3H_2O + 2(C_3H_5 3C_{18}H_{33}O_2)$, (Oleate of Glyceryl in Olive Oil) $= 3(Pb2C_{18}H_{33}O_2)$, Oleate of Lead $+ 2(C_3H_5 3HO)$, Glycerine.

Plumbi Oxidum or its Emplastrum is also contained in Emplastra Ferri, Galbani, Hydrargyri, Plumbi Iodidi, Resinæ, and Saponis.

From Plumbi Oxidum is made:

Plumbi Acetas.—Acetate of Lead. "Sugar of Lead." $Pb(C_2H_3O_2)_2,3H_2O$.

Source.—Made by heating Oxide of Lead in Acetic Acid and Water, and crystallising. $PbO + 2HC_2H_3O_2 + 2H_2O = Pb(C_2H_3O_2)_2,3H_2O$.

Characters.—White spongy-looking masses of interlaced acicular crystals, slightly efflorescent, having an acetous odour and a sweet astringent taste. *Solubility*, 10 in 25 of water, yielding a slightly acid solution. *Incompatibles.*—Hard water, mineral acids and salts, vegetable acids, alkalies, lime-water, iodide of potassium, all vegetable astringents, preparations of opium, albuminous liquids. *Impurity.*—Carbonate, detected by turbidity of aqueous solution. *Dose*, 1 to 4 gr.

Preparations.

a. PILULA PLUMBI CUM OPIO.—Acetate of Lead, 6; Opium, 1; Confection of Roses, 1. 1 of Opium in 8. *Dose*, 3 to 5 gr.

b. SUPPOSITORIA PLUMBI COMPOSITA.—Acetate of Lead, 36; Opium, 12; Oil of Theobroma, 132; in 12 suppositories. 1 gr. of Opium in each.

c. UNGUENTUM PLUMBI ACETATIS.—12 gr. to 1 oz. of Benzoated Lard.

From Plumbi Acetas are made:

α. **Liquor Plumbi Subacetatis.**—"Goulard Extract." $Pb_2O(C_2H_3O_2)_2$ dissolved in water.

Source.—Made by boiling Acetate of Lead, 5, and Oxide of Lead, 3½, in Water, 20; and filtering. $PbO + Pb2C_2H_3O_2 = Pb_2O(C_2H_3O_2)_2$.

Characters.—A dense, clear, colourless liquid, with a sweet astringent taste and alkaline reaction. Sp. gr. 1·275. Contains 24 per cent. of Subacetate of Lead.

Preparation.

LIQUOR PLUMBI SUBACETATIS DILUTUS. "Goulard Water." Solution of Subacetate of Lead, 1; Rectified Spirit, 1; Water, 78.

β. **Glycerinum Plumbi Subacetatis.**

Source.—Made by boiling together Acetate of Lead, 5; Oxide of Lead, 3½; Glycerine, 20; and Water, 12.

Preparation.

UNGUENTUM GLYCERINI PLUMBI SUBACETATIS.—4½, melted with 18 of Soft, and 6 of Hard, Paraffin.

2. Plumbi Carbonas.—Carbonate of Lead. "White Lead." A mixture of Carbonate and Hydrate. $2(PbCO_3),Pb2HO$.

Source.—Made by exposing Lead to the vapour of Acetic Acid, and at the same time to air loaded with Carbonic Acid Gas from spent tan. $6Pb + 6HC_2H_3O_2 + 3O_2$ (air) $+ 2CO_2 = 2(PbCO_3),Pb2HO + 2H_2O + 3(Pb2C_2H_3O_2)$ (residual acetate, which again becomes oxydised, the process being continuous).

Characters.—A soft, heavy, white powder. Insoluble in water; soluble in diluted acetic acid. *Impurity.*—Lime.

Preparation.

UNGUENTUM PLUMBI CARBONATIS.—1 to 7 of Simple Ointment.

3. Plumbi Nitras.—Nitrate of Lead. $Pb(NO_3)_2$.

Source.—Made by dissolving Lead in boiling Nitric Acid slightly diluted, and crystallising out. $PbO + 2HNO_3 = Pb(NO_3)_2 + H_2O$.

Characters.—Colourless octahedral crystals, of sweetish astringent taste; soluble in water and in alcohol.

From Plumbi Nitras is made:

Plumbi Iodidum.—Iodide of Lead. PbI_2.

Source.—Made by mixing solutions of Nitrate of Lead and Iodide of Potassium; washing and drying the precipitate. $Pb(NO_3)_2 + 2KI = PbI_2 + 2KNO_3$.

Characters.—A bright yellow powder or crystalline scales; tasteless; odourless; readily soluble in boiling water, falling out as brilliant crystalline scales when the solution cools.

Preparations.

a. EMPLASTRUM PLUMBI IODIDI.—1 in 10 with Lead Plaster and Resin.

b. UNGUENTUM PLUMBI IODIDI.—1 to 7 of Simple Ointment.

GENERAL CHEMICAL CHARACTERS OF PLUMBIC SALTS.

Salts of Lead give a black precipitate with H_2S; a white precipitate with Alkaline Carbonates, and also with Diluted H_2SO_4; and a yellow precipitate with KI.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Lead salts act readily upon wounds, ulcers, and exposed mucous membranes: (1) precipitating the albuminous fluids which cover their surface, or are flowing from them as a discharge: (2) coagulating the protoplasm of the young cells of the superficial layers; (3) *actively* contracting the small arteries and veins of the part, thus diminishing or even arresting the circulation within them, and preventing the escape of the plasma and blood cells through their walls; whilst (4) the nerves are probably also depressed. These effects are called, as a whole, **astringent, antiphlogistic, and sedative.** The Solutions of the Subacetate are much employed as applications to ulcers, as injections for chronic inflammatory discharges from the vagina, urethra, ear, etc.; or the Carbonate may be dusted upon ulcers, or used as Ointment. The Strong Solution of the Subacetate is a powerful irritant, causing pain and reaction, and is rarely used undiluted. The Nitrate is stimulant or even caustic, and is applied to syphilitic onychia and chapped nipples. The Iodide, in the form of the Unguentum, may be rubbed into enlarged joints, glandular swellings and nodes, to produce its absorbent effect, which is chiefly referable to the Iodine. When applied as an ointment, Lead may certainly enter the circulation, probably in consequence of decomposition; and the specific effects of the metal presently to be described may arise in this way. By the unbroken skin Lead is said not to be absorbed; yet the Subacetate is of unquestionable value in the treatment of contusions and superficial inflammations, such as erysipelas, probably from its astringent action on the blood-vessels. In the same form, or as the Ointment of the Subacetate, it relieves itching.

Internally.—The local action of Lead is first appreciated in the mouth as a peculiar astringent taste, with a sharp sweetness in the case of the Acetate. On the mucous membrane of the throat it acts in the manner already described: coagulating the mucus, producing an astringent effect on the cells and vessels of tho part, and causing a sensation of dryness. If inflammation be present it is rapidly controlled; and the Subacetate, either painted on in the form of the strong Solution, or as a gargle formed of the Diluted Solution, is an efficacious remedy for tonsillitis.

The local action of Lead is continued in the stomach and intestine: it diminishes the secretions, contracts the vessels, and arrests or retards the peristaltic movements; whilst it is itself converted into an albuminate by the fluids which it encounters. The Acetate is accordingly given, with or without Opium, to arrest hæmatemesis; and it is one of the most certain drugs in the treatment of obstinate diarrhœa, especially if ulceration be present and hæmorrhage threatening, as in typhoid fever (where it may be advantageously combined with Opium), and in tuberculosis of the bowels.

2. ACTION IN THE BLOOD.

Lead quickly enters the blood as albuminate, but passes very rapidly through it, and cannot be found in it even after large doses. If Lead be given for some time, the blood becomes more watery, and the red corpuscles fewer in number.

3. SPECIFIC ACTION.

All the tissues take up Lead freely from the blood, and retain it obstinately as albuminate. The central nervous system is an important seat of its deposit, whilst it is even more abundant in the kidneys and liver as the channels of its escape, and in the bones from the sluggishness of their metabolism. Thus combined with the active cells of the body, Lead after a timo sets up a series of symptoms known as "plumbism." These are pathological, not physiological, effects, and may bo briefly said to take the form of dyspepsia, constipation, and colic; a full, tense, and infrequent pulse, with increased cardiac action; disturbances of the urinary flow; neuralgic pains; tremors, followed by paralysis, of the muscles, chiefly affecting the extensors of the wrist; and finally anæmia, dropsy, and emaciation.

These symptoms and the results obtained by experiments on animals have been variously interpreted. Some authorities refer them to an irritant action of Lead on the involuntary muscular fibre of the stomach, bowels, and blood-vessels, similar to its astringent local effects, whence muscular contractions, painful spasms, narrowing of the vessels, and finally paralysis and other phenomena of exhaustion. Other pharmacologists contend that Lead acts primarily on the central nervous system and nerves, and only secondarily on the muscles, vessels, etc. Its remarkable effect in raising the blood pressure has been referred to irritation of the splanchnics, and consequent narrowing of the abdominal vessels; that is, to increased peripheral resistance. The increased blood pressure is the cause of the infrequent powerful cardiac action, and to some extent of the urinary disturbances.

4. SPECIFIC USES.

The specific action of Lead is turned to important uses. It is a powerful **hæmostatic**, used in bleeding from the stomach and bowel, as we have said, and also from the lungs, Opium being advantageously combined with it to ensure mental and bodily rest, as the Compound Pill or Suppository, or as Acetate of Lead, Acetate of Morphine, and Acetic Acid. Its use in diarrhœa is also partly referable to its specific action.

5. REMOTE LOCAL ACTION AND USES.

Lead is slowly excreted in the bile, urine, sweat, and milk. In the bowel, the portion that has been excreted by the liver is reabsorbed, is again excreted, and finally escapes in the fæces, as the black sulphide. In passing through the kidneys, Lead diminishes the excretion of uric acid. It is used as a hæmostatic in renal hæmorrhage; more rarely in bronchorrhœa and in profuse sweating.

6. ACTION AND USES OF THE DIFFERENT SALTS OF LEAD.

The special action and uses of the different preparations of Lead are as follows: The *Acetate* is the only salt given internally. The *Solutions of the Subacetate* are the only liquid preparations of the metal, and are used externally in lotions, injections, collyria, etc., as well as in the form of the Ointment. The *Oxide* is made into *Emplastrum Plumbi*, the basis of almost all plasters. The *Nitrate* is used as a local stimulant or escharotic; and pharmaceutically to obtain the *Iodide.* The latter possesses, as already described, absorptive powers, by virtue of the Iodine, an effect which the Lead probably promotes. *Plumbi Carbonas* is applied, in powder or as the Ointment, for astringent purposes, to ulcers and inflamed surfaces.

ARGENTUM. SILVER. Ag. 108.

Two salts of Silver are official, the Nitrate and the Oxide, as well as the metal itself.

Argentum Purificatum.—Refined Silver. Pure Metallic Silver.

Impurities.—Lead and copper.

From Argentum Purificatum is made:

Argenti Nitras.—Nitrate of Silver. Lunar Caustic. $AgNO_3$.

Source.—Made by dissolving Silver, by the aid of heat, in diluted Nitric Acid; evaporating; and crystallising, or pouring tho fused salt into moulds. To form Toughened Nitrate of Silver, 5 parts of KNO_3 are added to 95 parts of the $AgNO_3$ before fusion. *Characters.*—Colourless, tabular, right rhombic prisms, or white cylindrical rods. *Solubility,* 2 in 1 of water; 1 in 15 of spirit. *Incompatibles.*—Alkalics and their carbonatcs, chlorides, acids (except nitric and acetic), iodide of potassium, solutions of arsenic, and astringent infusions. *Impurities.*—Other nitrates, detected by evaporation of filtrate after precipitation with HCl. *Dose.*—$\frac{1}{6}$ to $\frac{1}{3}$ gr. in pill, or with Diluted Nitric Acid.

From Argenti Nitras are made:

a. **Argenti et Potassii Nitras.** — Mitigated Caustic.

Source.—Made by fusing togcther one part of Nitrate of Silver and two of Nitrate of Potassium, and pouring the product into moulds.

Characters.—White or greyish-white cylindrical rods or cones; freely soluble in distilled water, sparingly in spirit.

b. **Argenti Oxidum.**—Oxide of Silver. Ag_2O.

Source.—Made by precipitating a solution of Nitrate of Silver with Lime-Water, and washing. $2AgNO_3 + Ca2HO = Ag_2O + Ca2NO_3 + H_2O$.

Characters.—An olive-brown powder; slightly soluble in water. *Incompatible* with creasote or chlorides, with which it forms an explosive substance. *Impurities.*—Metallic silver; evolving gas with nitric acid. *Dose,* ½ to 2 gr. in pill.

GENERAL CHEMICAL CHARACTERS OF ARGENTIC SALTS.

Salts of Silver give a black precipitate with H_2S; a white curdy precipitate with HCl, blackening on exposure to light.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—In the form of the solid pencil, Nitrate of Silver is a **caustic**, causing destruction, with deep staining of the superficial layers, acute pain, inflammation of the deeper layers, separation of the part as a slough, and then rapid healing. Unlike Potash, its effects are limited to the area of application. On this account it is the best caustic for ordinary use, and may be employed to destroy the affected part in bites of dogs and venomous animals, and in post-mortem wounds, or to remove small growths, especially lupus.

Solutions of the Nitrate, when applied to the broken skin or a mucous membrane, exert much the same action as Lead, but in a greater degree: precipitating the albumins and the chlorides of the plasma or discharge; coagulating the protoplasm of the young cells of the part; causing *active* contraction of the arteries, veins, and capillaries; and very rapidly coagulating the blood both within and without them. Nitrate of Silver, or Mitigated Caustic, is the best of all local **antiphlogistics**, controlling the exudation, growth, and vascular disturbance of the inflammatory process. It is employed to touch callous and weak ulcers, including bed-sores; in diseases of the eye, such as ophthalmia and granular lids; and, as an injection, to wash inflamed surfaces, for example, the urethra, vagina, os uteri, and bladder. Solid caustic is an excellent **hæmostatic** in bleeding from leech-bites. A weak solution is used to harden the skin in threatening bed-sores.

Internally.—In the mouth, Silver meets with chlorides and albuminous fluids, combines with these, and acts on the surface of the mucous membrane as it does on the skin. It is a useful remedy in inflammation of the tonsils and pharynx, whether applied in the solid form as an antiphlogistic in acute cases, or in solution as an **astringent** in relaxed, chronic states.

Reaching the stomach, Nitrate of Silver is decomposed by the hydrochloric acid and mucus, and cannot act as an irritant upon the mucous membrane unless given in poisonous doses. Its use in ulcers of the stomach must therefore be questioned. When given *per rectum* for ulceration of the bowels it certainly possesses more action.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Silver slowly enters the blood as albuminate, or is absorbed as the pure metal by the lacteals, after the manner of fat. It has no obvious effect on the blood.

Silver becomes locked up, in the metallic form, in all the connective tissues of the body, staining exposed parts a dusky black-brown, incapable of removal. It probably, therefore, remains inert within tho body; but some authorities believe that it affects the nervous tissues, and recommend it in epilepsy, chorea, and locomotor ataxy. The permanent unsightly discoloration of the skin is a serious objection to its employment.

Although Silver once admitted to the tissues is not excreted, a certain amount has been found in the urine; and a proportion always passes through the bowels unabsorbed, appearing in the fæces as sulphide.

ACTION AND USES OF THE DIFFERENT SALTS OF SILVER.

The *Nitrate* is almost invariably used both externally and internally; but the *Nitrate of Silver and Potassium* must be substituted in diseases of the eye. Tho *Oxide* is less irritant, and is chiefly given internally, in the form of pill.

ZINCUM. ZINC. Zn. 65.

There are two primary sources of the official salts and preparations of Zinc, namely: (1) the metal; and (2) Calamine, the native Carbonate.

1. Zincum.—Zinc of Commerce.

Source.—Obtained by roasting the native Sulphide or Carbonate, and reducing the resulting oxide with Charcoal.

Characters.—A bluish-white metal.

From Zincum is made:

Zincum Granulatum.—Made by fusing Zinc, and pouring it into cold water.

From Zincum Granulatum are made :

1. **Zinci Chloridum.**—Chloride of Zinc. $ZnCl_2$.

Source.—Made by (1) dissolving Granulated Zinc in diluted Hydrochloric Acid, and boiling; then adding in succession (2) Chlorine Water, and (3) Carbonate of Zinc, to precipitate iron or lead present as impurities; filtering, evaporating, and pouring into moulds. (1) $Zn_2 + 4HCl = 2ZnCl_2 + 2H_2$. (2) $2FeCl_2 + Cl_2 = Fe_2Cl_6$. (3) $Fe_2Cl_6 + 3ZnCO_3 + 3H_2O = Fe_26HO + 3ZnCl_2 + 3CO_2$. Also $PbCl_2 + Cl_2 + 2ZnCO_3 = PbO_2 + 2ZnCl_2 + 2CO_2$.

Characters. — Colourless rods or tablets, very deliquescent, and caustic. *Solubility*, 10 in 4 of water, freely in spirit and ether. *Impurities.*—Sulphates, iron, and calcium.

2. **Liquor Zinci Chloridi.**

Source.—Made as above, with partial evaporation.

Characters.—Colourless, with sweetish astringent taste. Contains 366 gr. in 1 fl.oz.

3. **Zinci Sulphas.**—Sulphate of Zinc. $ZnSO_4, 7H_2O$.

Source.—Made from Zinc and Sulphuric Acid, like the Chloride, with similar precautions, but crystallising. (1) $Zn_2 + 2H_2SO_4 = 2ZnSO_4 + 2H_2$; and (2) $2FeSO_4 + Cl_2 + 3ZnCO_3 = 2ZnSO_4 + ZnCl_2 + Fe_2O_3 + 3CO_2$.

Characters.—Minute colourless prisms, with a metallic styptic taste. *Solubility*, 10 in 7 of water; insoluble in spirit. *Impurities.*—Iron, lead, copper, arsenic.

Dose.—1 to 3 gr. as a tonic; 10 to 30 gr. as an emetic.

From Zinoi Sulphas are made :

a. **Zinci Carbonas.**—Carbonate of Zinc. $ZnCO_3(Zn2HO)_2,H_2O$.

Source.—Made by decomposing a solution of Sulphate of Zinc with a solution of Carbonate of Sodium, boiling for 15 minutes; washing the precipitate with boiling water, and drying. $3ZnSO_4 + 2H_2O + 3Na_2CO_3 = ZnCO_3(Zn2HO)_2 + 2CO_2 + 3Na_2SO_4$.

Characters.—A white, tasteless, inodorous powder, insoluble in water. An impure carbonate. *Impurities.*—Sulphates, chlorides, copper.

From Zinci Carbonas are made:

a. **Zinci Oxidum**. — Oxide of Zinc. ZnO.

Source.—Made by heating the Carbonate. $ZnCO_3(Zn2HO)_2,H_2O = 3ZnO + 3H_2O + CO_2$.

Characters. — A soft, nearly white, tasteless and inodorous powder, insoluble in water. *Impurities.*—The carbonate; effervescing with acids. Also its impurities. *Dose*, 2 to 10 gr.

Preparation.

UNGUENTUM ZINCI.—1 to $5\frac{1}{2}$ of Benzoated Lard.

From Zinci Oxidum are made:

i. **Oleatum Zinci**. — Oleate of Zinc. $Zn2C_{18}H_{33}O_2$.

Source.—Made by heating 1 of the Oxide with 9 of Oleic Acid. $ZnO + 2HC_{18}H_{33}O_2 = Zn2C_{18}H_{33}O_2 + H_2O$.

Characters.—A light brown, oleaginous, semisolid substance, having a slight smell of Oleic Acid.

Preparation.

UNGUENTUM ZINCI OLEATI. — 1, with 1 of Soft Paraffin.

ii. **Zinci Sulphocarbolas**. — See *Acidum Carbolicum*, page 188.

β. **Zinci Acetas**. — Acetate of Zinc. $Zn(C_2H_3O_2)_2,2H_2O$.

Source. — Made by dissolving Carbonate of Zinc in Acetic Acid and Water; boiling; and crystallising. $ZnCO_3(Zn2HO)_2,H_2O + 6C_2H_4O_2 = 3Zn(C_2H_3O_2)_2 + 6H_2O + CO_2$.

Characters.—Thin, translucent, colourless crystalline plates, of a pearly lustre;

with sharp, unpleasant taste. *Solubility*, 10 in 25 of water. *Impurities.*—Those of the Carbonate. *Dose.*—1 to 2 gr. as a tonic; 10 to 20 gr. as an emetic.

Zinci Carbonas is also used in making:
Zinci Chloridum and Zinci Sulphas.

b. **Zinci Valerianas.**—Valerianate of Zinc. See *Valerianæ Rhizoma*, page 304.

2. Calamina Præparata.—Prepared Calamine.
Source.—Native Carbonate of Zinc, calcined, powdered, and freed from gritty particles by elutriation.

Characters.—A buff powder, almost entirely soluble in acids.

Preparation.

UNGUENTUM CALAMINÆ.—1 to 5 of Benzoated Lard.

GENERAL CHEMICAL CHARACTERS OF ZINC SALTS.

Salts of Zinc give a white precipitate with $(NH_4)_2S$, insoluble in excess; a white precipitate with Ammonium Carbonate, soluble in excess.

Incompatibles of Zinc Salts in General.

Alkalies and their carbonates, lime-water, acetate of lead, nitrate of silver, astringent vegetable infusions or decoctions, and milk.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The salts of Zinc closely resemble in their action the salts of Lead, Silver, and Copper, being **caustic** in their stronger forms, **astringent or antiphlogistic** in their weaker forms. Zinc presents every degree of this action, according to the salt employed, that is, probably according to the solubility and diffusion power of the particular combination of the metal. Thus the Chloride, which is highly deliquescent, penetrates the tissues, and is a powerful escharotic, causing destruction of the part, with severe pain, separation of a slough, and subsequent healing. It is employed to destroy morbid growths, chronic ulcers, and gangrenous parts, in the form of a paste or solid arrows made with plaster of Paris or flour, or as a strong solution. The Sulphate and Acetate have less affinity for water, and are much less powerful than the Chloride. When applied to the broken skin, an ulcer, or an exposed mucous surface, they precipitate the albuminous juices or secretions, coagulate the protoplasm of the upper layers of growing cells, and indirectly cause contraction of the vessels, though less than Silver and Lead. The Sulphate of Zinc is the most common of all applications for healing ulcers and wounds, limiting the amount of discharge, checking excessive or "weak" growth, and modifying the intensity of the inflammatory process with which the healing is associated. A solution of this salt is the basis of the ordinary "Red Lotion" of many hospital pharmacopœias; and other weak solutions of the same may be employed as a wash or injection for the eyes, urethra, vagina, and other accessible mucous tracts. The Oxide, Oleate, Carbonate, and Calamine, act locally as mild astringents in inflamed conditions of the superficial layers of the skin such as eczema, controlling exudation and hyperæmia, and protecting the parts from the air. Being insoluble in water, they are applied in the form either of powder or ointment. The value of preparations of Zinc is referable in part to their **powerfully disinfectant** properties, a lotion of the Chloride (40 gr. to 1 fl.oz. of Water) preventing decomposition for several days.

Internally, the local action of Zinc corresponds. It is but little used in the mouth or throat, but its effect on the stomach as a local irritant furnishes us with the most familiar of our **direct emetics**. Sulphate of Zinc, in doses of 20 grains, causes rapid and complete vomiting, attended by less immediate depression and less subsequent nausea than Antimony and Ipecacuanha. It is much employed in narcotic poisoning; more rarely in croup, diphtheria, and phthisis, to clear the air passages; or even to empty the stomach in painful dyspepsia. The Oxide on reaching the stomach is partly dissolved, and acts like the soluble salts of Zinc.

In the intestine the irritant action of Zinc is continued, if it be given in large doses, but this effect is never desired therapeutically. On the contrary, the Oxide, in sufficient doses to relieve a moderate superficial catarrh, is often a very efficacious **astringent** in the treatment of diarrhœa in children.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Zinc enters the circulation very slowly, but nothing is known respecting its influence on the plasma or corpuscles that can be turned to therapeutical account.

The action of Zinc upon the tissues has been learned chiefly from its effect on workers in the metal. When it finds its way into the body for a length of time, it is a direct **depressant to**

the nervous centres, especially the sensory parts of the spinal cord, and thus indirectly weakens and disturbs the muscular system. It has been employed with unquestionable success in epilepsy, chorea, and whooping cough, all of which are characterised by nervo-muscular excitement.

3. REMOTE LOCAL ACTION AND USES.

The kidney, mammary gland, and probably the mucous surfaces and skin, are the channels of elimination of Zinc. It is possible that the metal exerts a second or **remote astringent** effect on these parts as it is leaving the system; for the Sulphate and Oxide appear to have the power of arresting chronic discharges from remote mucous passages, such as the uterus and vagina, even when given internally; and it is certain that the Oxide diminishes the perspirations of phthisis in some instances.

4. ACTIONS AND USES OF THE DIFFERENT SALTS OF ZINC.

These have been sufficiently indicated in the preceding description. The *Chloride* stands alone as a powerful escharotic, never to be given internally; it possesses also disinfectant properties, as the *Liquor Zinci Chloridi*, which is used to mop out very foul wounds, and very extensively to wash infected rooms, flush drains, etc. (Burnett's disinfectant.) The *Sulphate* and *Acetate* closely resemble each other in their action, but the Acetate is little used. The *Oxide*, *Carbonate*, *Oleate*, and *Calamine* are similarly allied, the first being most employed. *Zinci Valerianas* probably acts as a Zinc salt only, the Valerianic Acid appearing to be inert. See *Valerianæ Rhizoma*, page 304.

CUPRUM. COPPER. Cu. 63·5.

The Sulphate and Nitrate are the only salts of Copper employed medicinally, although other compounds, as well as the metal itself, are introduced into the Pharmacopœia for chemical purposes.

Cuprum.—Fine Copper Wire, about No. 25 gauge, or about 0·02 inch.

From Cuprum is made:

1. **Cupri Sulphas.**—Sulphate of Copper. $CuSO_4$, $5H_2O$. Blue Vitriol. Bluestone.

Source.—Made by heating Copper with Sulphuric Acid; dissolving the soluble product in hot water;

evaporating, and crystallising. $4H_2SO_4 + Cu_2 = 2CuSO_4 + 2SO_2 + 4H_2O$.

Characters.—Deep blue crystals, in oblique prisms; taste strongly styptic and metallic. *Solubility,* 1 in 3 of water, yielding a strongly acid solution. *Impurity.*—Iron. *Incompatibles.*—Alkalies and their carbonates, lime-water, mineral salts (except sulphates), iodides, and most vegetable astringents.

Dose.—As an astringent or tonic, ¼ to 2 gr.; as an emetic, 5 to 10 gr.

2. **Cupri Nitras.**—Nitrate of Copper. $Cu(NO_3)_2 3H_2O$.

Source.—Made by dissolving Copper in Diluted Nitric Acid; evaporating, and crystallising.

Characters.—Deep blue prismatic crystals; very deliquescent, highly corrosive.

Copper Wire is used for preparing Spiritus Ætheris Nitrosi.

Preparations of Copper for Chemical Testing (*Appendix B.P.*).

1. Copper Foil.
2. Subacetate of Copper of Commerce, Verdigris, Œrugo. $(C_2H_3O_2)_2Cu,CuO$. In powder, or masses of very minute crystals of a bluish-green colour.
3. Sulphate of Copper, Anhydrous. $CuSO_4$. A yellowish white powder, becoming blue with water. Made by heating Sulphate of Copper to 400° Fahr.
4. Solution of Acetate of Copper.
5. Solution of Ammonio-Sulphate of Copper.

GENERAL CHEMICAL CHARACTERS OF CUPRIC SALTS.

Salts of Copper give a black-brown precipitate with H_2S. Their solutions become deep blue with excess of NH_4HO; and deposit metallic Copper on a polished iron surface.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The action of Copper differs but little from that of Silver and Zinc. It does not affect the unbroken skin, nor is it absorbed by it into the blood. Applied freely to wounds, ulcers, or the delicate surface of exposed mucous membranes, such as the conjunctiva, the Sulphate ("Bluestone") is **caustic**, and is in frequent requisition to control exuberant granulations, touch granular lids, and for allied purposes. A swift and slight application of the crystal, or its solution in water, acts so far like Nitrate of Silver: precipitating the discharges from a mucous or ulcerated surface; coagulating the superficial layers; thus contracting the blood-vessels and arresting discharge. It is used as a **stimulant** to ulcers; and a solution of 2 to 5 gr. to the oz. may be used as an **astringent** lotion, or injected into the vagina, rectum, or urethra. The Nitrate resembles the Sulphate in its action, but is stronger.

Internally.—The local action of Copper on the mouth, including its astringent metallic taste, corresponds with that just described. If long administered, it may cause a greenish discoloration of the bases of the teeth (*not* of the gums), from direct combination with decomposing products there.

Sulphate of Copper, in large doses (10 gr.), is not entirely converted into an albuminate in the stomach, but acts on the mucous membrane as an irritant, and causes vomiting. It is a rapid **direct emetic**, and is suited for administration when the stomach is to be surely and speedily emptied of a narcotic poison, such as opium, or the air passages evacuated of mucus or false membrane, as in bronchitis and diphtheria, after Ipecacuanha has failed. It causes less depression and subsequent nausea than Tartar Emetic. If Sulphate of Copper fail to vomit, the stomach must be evacuated by some other means, lest dangerous inflammation result.

Lastly, Copper Sulphate is a valuable antidote to Phosphorus, as it is reduced by the metalloid, the Copper being deposited upon the Phosphorus, and rendering it inert. In cases of poisoning by Phosphorus, 3 gr. of Bluestone should be given in water every few minutes, until vomiting occurs, whereupon a free saline purgative is to be administered.

In the intestines Copper is an **astringent** in small quantities; an irritant purgative in larger quantities. Small doses, combined usually with Opium, are given for some kinds of diarrhœa.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Given in small doses, Copper is very slowly absorbed into the blood; but we neither know any effect that it produces here, nor use it in this connection.

Its specific action on the tissues is most difficult to evoke. It is said to weaken the voluntary muscles and heart, and to affect the nutrition of the central nervous system; whence it was formerly used in convulsive and spasmodic diseases, including epilepsy, chorea, and hysteria. This treatment is now almost obsolete. It is believed by some to be a specific astringent to the uterus.

Copper is chiefly excreted by the liver, that is, leaves the body with the bile and fæces; part is discharged in the urine, and part by the saliva. The metal possibly exerts some astringent action during its elimination by these channels.

ALUMINIUM. Al. 27·5.

Only one salt of this metal is official.

Alumen. — Alum. $Al_23SO_4,K_2SO_4,24H_2O$, or $Al_23SO_4,(NH_4)_2SO_4,24H_2O$. A Sulphate of Aluminium and Potassium (Potassium Alum) or of Aluminium and Ammonium (Ammonium Alum), crystallised from solution in water.

Source.—Made from Alum Schist (silicate of alumina and sulphide of iron) by roasting and exposure to air; lixiviating; crystallising out the ferrous sulphate; adding either Sulphate of Potassium or Sulphate of Ammonium to the liquor, and crystallising.

Characters.—Colourless transparent octahedra, with an acid, sweetish, astringent taste. *Solubility*, 1 in 10 of cold, 10 in 8 of boiling, water; 1 in 4 of glycerine. Very acid. *Incompatible* with alkalies, lime, baryta, lead, tartrates, tannic acid, mercury, and iron. *Impurities.*—Sulphate of iron and silicates. *Dose*, 10 to 20 gr.

Preparation.

GLYCERINUM ALUMINIS.—1 to 5, with gentle heat.

From Alumen is made:

Alumen Exsiccatum.—Dried Alum.

Source:—Made by heating Potassium Alum up to 400° Fah., till aqueous vapours cease to be disengaged; and powdering.

Characters.—An opaque white bulky powder, or spongy masses. Has lost 45 per cent. by heating. Slowly but completely soluble in water; and unites readily with it.

GENERAL CHEMICAL CHARACTERS OF ALUMINIUM SALTS.

Salts of Aluminium give a gelatinous whitish precipitate with $(NH_4)_2S$, soluble in Liquor Potassæ.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Alum possesses the **astringent and styptic** effects fully discussed under *Plumbum*, page 63. In the form of powder, it arrests bleeding from the nose, gums, and other accessible parts. Dried alum absorbs water, and is somewhat **caustic** if the skin be broken, for instance over ulcers. It is used to destroy weak exuberant granulations.

As an injection in discharges from the rectum, vagina, uterus, and urethra, Alum is in constant use; as a wash for conjunctivitis it must be used with caution.

Internally.—The local action of Alum is appreciated in the mouth as an "astringent taste," and in the throat as "dryness," the mucous secretions of the parts being coagulated, and the membrane constringed, especially if it be inflamed and swollen. Alum is therefore used as a mouth wash in ulceration and tender gums, and as a remedy for sore throat in the form of gargles or sprays, variously combined with other substances. A similar effect is produced on the mucous membrane of the stomach and intestines, dyspepsia and constipation being the result; in large doses it is an **emetic**, irritant, and purgative. A teaspoonful mixed with syrup is an excellent vomit in croup. In doses of 30 gr., frequently repeated, it relieves lead colic by opening the bowels, and probably precipitating the soluble salts of lead.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION AND USES.

Alum is absorbed into the blood, probably as an albuminate. It is believed to possess astringent properties when it reaches the tissues, arresting hæmorrhage and chronic inflammatory discharges from the mucous membranes; and is used in the treatment of hæmoptysis, epistaxis, gleet, diarrhœa, and even whooping-cough. Much of this is doubtful. Alum is excreted by the kidneys, and may arrest hæmorrhage from these organs. Part of the salt possibly escapes by the skin, as it proves useful in some cases of excessive sweating.

SUB-GROUP II.

FERRUM. IRON. Fe. 56.

All the official salts and preparations of Iron are made from the metal, directly or indirectly.

Ferrum.—Iron. Annealed Iron Wire, No. 35, or Wrought-iron Nails; free from oxide.

From Ferrum are made:

1. **Ferri Sulphas.**—Sulphate of Iron. $FeSO_4,7H_2O$.

Source.—Made by dissolving Iron Wire in Sulphuric Acid and Water; boiling; filtering; crystallising; and drying.

Characters.—Pale-green, oblique rhombic prisms, with a styptic taste. *Solubility,* 1 in 1½ of water; insoluble in spirit. *Impurities.*—Persalts, giving sediment in aqueous solution. Copper; precipitated by H_2S. *Dose,* 1 to 5 gr.

Preparations.

a. MISTURA FERRI COMPOSITA. — "Griffiths' Mixture." Sulphate of Iron, 25 gr.; Carbonate of Potassium, 30 gr.; Myrrh, 60 gr.; Sugar, 60 gr.; Spirit of Nutmeg, 4 fl.dr.; Rose Water, 9½ fl.oz. $FeSO_4 + K_2CO_3 = FeCO_3 + K_2SO_4$. A dark-green mixture, containing the Carbonate. *Dose,* 1 to 2 fl.oz.

b. PILULA ALOES ET FERRI.—1 in 7. See *Aloes,* page 393.

From Ferri Sulphas are made:

c. **Ferri Sulphas Exsiccata.**—$FeSO_4,H_2O$.

Source.—Made by heating the Sulphate to 212° Fahr., when it loses $\frac{6}{7}$ of its water; and powdering.

Characters. — A dirty white powder. 2½ gr. = about 4 gr. of the crystalline Sulphate. *Dose,* ½ to 3 gr.

d. **Ferri Carbonas Saccharata.**—About one-third Carbonate of Iron, $FeCO_3$, mixed with two-thirds of Peroxide of Iron and Sugar.

Source.—Made by precipitating a solution of Sulphate of Iron with Carbonate of Ammonium; rubbing the washed precipitate with sugar; and drying. (1) $FeSO_4 + (NH_4)_2CO_3 = FeCO_3 + (NH_4)_2SO_4$. (2) $3FeCO_3 + O$ (from exposure) $= FeCO_3 + Fe_2O_3 + 2CO_2$. The sugar helps to prevent further oxydation.

Characters.—Grey-brown lumps, with a sweet chalybeate taste. *Impurities.*—Sulphate of Ammonium; excess of Oxide of Iron. *Dose,* 5 to 30 gr.

Preparation.

PILULA FERRI CARBONATIS. — 4, to 1 of Confectio Rosæ. *Dose,* 5 to 20 gr.

e. **Ferri Arsenias.**—Arseniate of Iron. Arseniates of Iron, with some Oxide.

Source.—Made by mixing hot solutions of Arseniate of Sodium and Sulphate of Iron; adding Bicarbonate of Sodium; and washing and drying the precipitate. $3FeSO_4 + 2Na_2HAsO_4 + 2NaHCO_3 = Fe_3As_2O_8 + 3Na_2SO_4 + 2H_2O + 2CO_2$.

Characters.—A greenish amorphous powder, tasteless (but not to be tasted); insoluble in water; readily soluble in HCl. *Impurities.*—Sulphates, and general impurities. *Dose,* $\frac{1}{16}$ to $\frac{1}{2}$ gr. in pill.

f. **Ferri Phosphas.**—Phosphate of Iron. Ferrous Phosphate, $Fe_3(PO_4)_2,8H_2O$, 47 per cent., with Ferric Phosphate and some Oxide.

Source.—Made by mixing warm solutions of Phosphate of Sodium and Sulphate of Iron; adding Bicarbonate of Sodium; and washing and drying the precipitate. $3FeSO_4 + 2Na_2HPO_4 + 2NaHCO_3 = Fe_3(PO_4)_2 + 3Na_2SO_4 + 2H_2O + 2CO_2$.

Characters.—A slate-blue amorphous powder; insoluble in water, soluble in HCl. *Impurity.*—Arsenic. *Dose,* 5 to 10 gr.

g. **Liquor Ferri Persulphatis.**—

Source.—Made from a hot solution of Sulphate of Iron in Sulphuric Acid and Water, by boiling with Nitric Acid and Water. $6FeSO_4 + 3H_2SO_4 + 2HNO_3 = 3(Fe_2 3SO_4) + 4H_2O + 2NO$.

Characters.—A dark-brown, inodorous, very astringent solution, miscible with water.

From Liquor Ferri Persulphatis are made:

α. **Ferri Peroxidum Hydratum.**—Peroxide of Iron. Fe_2O_22HO.

Source.—Made by precipitating diluted Solution of the Persulphate with Solution of Soda, and drying. (1) $Fe_23SO_4 + 6NaHO = Fe_26HO + 3Na_2SO_4$. (2) $Fe_26HO = Fe_2O_22HO + 2H_2O$.

Characters. — A reddish-brown powder, without taste; not magnetic. *Dose,* 5 to 30 gr.

Preparation.

EMPLASTRUM FERRI.—1; with Burgundy Pitch, 2; and Lead Plaster, 8.

β. **Ferri et Ammonii Citras.**—Citrate of Iron and Ammonium.

Source.—Mado by precipitating diluted Solution of Ammonia with diluted Solution of Persulphate; drying; dissolving the resulting Hydrate in a hot solution of Citric Acid; neutralising with Ammonia; evaporating, and drying in thin layers on porcelain or glass plates.

Characters.—Deep red scales, deliquescent; slightly sweet and astringent in taste. *Solubility,* 10 in 5 of water, giving a feebly acid solution; almost insoluble in spirit. *Impurities.*—Tartrates; giving a crystalline precipitate with Acetic Acid; alkaline salts, detected in ash. *Dose,* 5 to 10 gr.

Preparation.

VINUM FERRI CITRATIS.—1 gr. in 1 fl.dr. of Orange Wine. *Dose,* 1 to 4 fl.dr.

γ. **Ferri et Quininæ Citras.**—Citrate of Iron and Quinine.

Source.—Made like Ferri et Ammonii Citras, freshly precipitated Quinine being also dissolved in the Citric Acid solution.

Characters.—Greenish-yellow scales, deliquescent; bitter and chalybeate in taste. *Solubility,* 2 in 1 of water, the solution being very slightly acid; 6·25 gr. contain 1 gr. of Quinine. *Impurities.*—Alkaline salts, detected in the ash; other alkaloids instead of Quinine, insoluble in ether when precipitated by NH_4HO. *Dose*, 5 to 10 gr.

δ. **Ferrum Tartaratum.**—Tartarated Iron.

Source.—Made like Ferri et Ammonii Citras, with Acid Tartrate of Potassium instead of Citric Acid.

Characters.—Garnet scales, slightly sweetish and astringent. *Solubility*, 1 in 4 of water; sparingly in spirit. *Impurities.*—Ammonia, evolved by boiling with Liquor Sodæ; ferrous salts. *Dose*, 5 to 10 gr.

ε. **Liquor Ferri Acetatis Fortior.**

Source.—Made by precipitating diluted Solution of Persulphate with diluted Solution of Ammonia; drying; dissolving the resulting Hydrate in Glacial Acetic Acid; and diluting. (1) $Fe_23SO_4 + 6NH_4HO = Fe_26HO + 3(NH_4)_2SO_4$. (2) $Fe_26HO + 6HC_2H_3O_2 = Fe_26(C_2H_3O_2) + 6H_2O$.

Characters.—A deep red fluid, with a sour styptic taste and acetous odour; miscible with water or rectified spirit in all proportions. Sp. gr. 1·127. *Dose*, 1 to 8 min.

Preparations.

(i) Liquor Ferri Acetatis.—1 to 3 of Water. *Dose*, 5 to 30 min.

(ii) Tinctura Ferri Acetatis.—5; with Acetic Acid, 1; Spirit, 5; and Water, 9. *Dose*, 5 to 30 min.

2. **Ferri Sulphas Granulata.**—Granulated Sulphate of Iron. $FeSO_4,7H_2O$.

Source.—Made by dissolving Iron Wire in Sulphuric Acid and Water; boiling; pouring into Rectified Spirit, stirring the mixture; and drying.

Characters.—Small, pale greenish-blue, granular crystals. *Solubility*, 1 in 1½ of water; insoluble in spirit. *Impurities.*—Same as of Ferri Sulphas. *Dose*, 1 to 5 gr.

Preparation.

Syrupus Ferri Phosphatis.—1 gr. of Anhydrous Ferri Phosphas, $Fe_3(PO_4)_2$, in 1 fl.dr.

Source.—Made by precipitating a solution of Granulated Sulphate with a solution of Phosphate of Sodium, adding Bicarbonate of Sodium; dissolving the precipitate in Concentrated Phosphoric Acid; and adding Sugar and Water. Colourless, becoming brown. *Dose*, 1 fl.dr.

3. **Liquor Ferri Perchloridi Fortior.**—Strong Solution of Perchloride of Iron.

Source.—Made by (1) dissolving Iron Wire in Hydrochloric Acid and Water; (2) adding Hydrochloric Acid, and pouring into Nitric Acid; evaporating and diluting. (1) $Fe + 2HCl = FeCl_2 + H_2$. (2) $6FeCl_2 + 6HCl + 2HNO_3 = 3Fe_2Cl_6 + 4H_2O + 2NO$.

Characters.—An orange-brown liquid, consisting of Perchloride of Iron, Fe_2Cl_6, in solution in water. 2 oz. of Iron in 10 fl.oz. *Impurity*, Ferrous salts.

Preparations.

a. LIQUOR FERRI PERCHLORIDI.—Pale brown. 1 of Strong Solution to 3 of Water. *Dose*, 10 to 30 min.

b. TINCTURA FERRI PERCHLORIDI. — Light brown. 1 of Strong Solution to 1 of Spirit and 2 of Water. *Dose*, 10 to 30 min.

From Liquor Ferri Perchloridi Fortior are made:

c. **Ferrum Redactum.**—Reduced Iron. Metallic Iron with a variable amount of Oxide.

Source.—Made by (1) precipitating diluted Solution of the Perchloride by diluted Solution of Ammonia; drying; and (2) passing dry hydrogen gas in a heated gun-barrel over the resulting Oxyhydrate. (1) $Fe_2Cl_6 + 6NH_4HO = Fe_26HO + 6NH_4Cl$. (2) $Fe_2O_22HO + 3H_2 = Fe_2 + 4H_2O$.

Characters. — A fine greyish-black powder, strongly attracted by the magnet. *Impurity.*—Excess of oxide, detected volumetrically. *Dose*, 1 to 5 gr.

Preparation.

TROCHISCI FERRI REDACTI.—1 gr. in each. *Dose*, 1 to 6.

d. **Liquor Ferri Dialysatus.** — A solution of highly basic Ferric Oxychloride, or Chloroxide of

Iron $Fe_2Cl_6,n(Fe_2 6HO)$, from which most of the acidulous matter has been removed by dialysis.

Source.—Made by dissolving in Strong Solution of Perchloride of Iron, Ferric Hydrate, freshly precipitated from diluted Solution of the Perchloride by Ammonia (see *Ferrum Redactum*); and washing with water in a dialyser to remove the acidulous matter.

Characters.—A clear dark reddish-brown liquid, free from any marked ferruginous taste; neutral. 100 gr. contain 5 gr. of Iron. *Dose*, 10 to 30 min.

4. **Liquor Ferri Pernitratis.** — Solution of Pernitrate of Iron, $Fe_2 6NO_3$, in water.

Source.—Made by dissolving Iron Wire in Nitric Acid and Water. $Fe_2 + 8HNO_3 = Fe_2 6NO_3 + 4H_2O + 2NO$.

Characters.—A clear reddish-brown liquid, slightly acid and astringent to the taste. 1 fl.dr. yields 2·6 gr. of oxide. *Impurities.*—Ferrous salts. *Dose*, 10 to 40 min.

5. **Mistura Ferri Aromatica.***—Iron Wire, ½; Red Cinchona Bark, 1; Calumba, ½; Cloves, ¼; Compound Tincture of Cardamoms, 3; Tincture of Orange Peel, ½; and Peppermint Water, 12½. Macerate for three days, and filter. *Dose*, 1 to 2 fl.oz.

6. **Vinum Ferri.** — Iron Wire digested in Sherry for thirty days. 1 in 20. *Dose*, 1 to 4 fl.dr.

7. **Pilula Ferri Iodidi.**—Made by mixing a solution of Iron and Iodine in Water, with Sugar and Liquorice. 1 in 3½. *Dose*, 3 to 8 gr.

8. **Syrupus Ferri Iodidi.**—4·3 gr. of Iodide in 1 fl.dr. Made by mixing a hot solution of Iron Wire and Iodine in Water with Syrup. Colourless. *Dose*, 30 to 60 min.

GENERAL CHEMICAL CHARACTERS OF IRON SALTS.

Proto-Salts give with $(NH_4)_2S$ a black precipitate; with Ferrocyanide of Potassium a precipitate at first white, afterwards blue; with Ferricyanide of Potassium a dark blue precipitate. *Persalts* give a black precipitate with $(NH_4)_2S$; a blue with Ferrocyanide of Potassium; a blue-black with Tincture of Galls.

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* In this, and in all other preparations described in the *Manual*, where the relative (not actual) amounts of the ingredients are stated, solids are estimated in *parts by weight*, liquids in *fluid parts*.

Incompatibilities of Preparations of Iron in General.

Alkalies and their Carbonates, Lime-Water, Carbonate of Lime, Magnesia and its Carbonate, give green precipitates with Proto-Salts, brown with Persalts. Tannic and Gallic Acids give a deep blue-black with Persalts; and preparations of Iron, therefore, tinge Infusion of Chiretta and Hops, and change to brown or black those of Chamomile, Cusparia, Gentian, Orange, Cascarilla, Cloves, Digitalis, Cinchona, and all astringent infusions, but they can be given in Infusion of Quassia or Calumba.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—A solution of a Persalt of Iron has a corrugating and **astringent** effect upon the broken skin and mucous surfaces: coagulating the albuminous tissues, plasma, and blood; and constringing or condensing the elements. The blood-vessels are thus closed or diminished in size, not actively, as by Lead and Silver, but by compression from without; the circulation through them is diminished; hæmorrhage, if present, is arrested; and the abnormal escape of plasma and leucocytes, which characterises chronic inflammation or catarrh, is checked. Solutions of the Ferric salts are therefore used as **hæmostatics or styptics,** to arrest hæmorrhage from accessible parts, such as leech-bites, the nose, and uterus; to cure nævi; less extensively in chronic discharges from the vagina, rectum, and nose, as astringents. Injected into the rectum, they destroy worms. Iron is not absorbed by the unbroken skin.

Internally.—The constringent effect of Iron is appreciated in the mouth as a "styptic taste," whilst the teeth and tongue are blackened by the sulphide formed by decomposition. Beyond this, the local action corresponds with that just described externally. Various Iron solutions are usefully applied, either as gargles or with the brush, in some forms of chronic sore throat.

In the stomach all the salts of Iron, whatever their nature, are converted into the chloride, and do not combine with the acid albuminates, like some of the other metals. If Iron be given in excess, or if the Hydrochloric Acid of the juice or the food be deficient, the metal decomposes the whole of the digestive fluid, and acts upon the mucous membrane as an astringent and irritant. Iron is thus directly **unfavourable to digestion**; and in this connection we must carefully note: (1) that Iron may disorder the digestion, even in healthy subjects; (2) that it must not be given for disease until the gastric functions have been so far restored; (3) that it is well to begin then with the mildest preparations; and (4) that it must be given after meals. Humid Peroxide of Iron ($Fe_2 6HO$) is a valuable **antidote** in arsenical poisoning, forming with Arsenious Acid an almost insoluble compound, a basic Arsenite of variable constitution. The humid Peroxide, which must be given freshly prepared, is best made by mixing 3 fl.oz. of the Solution of Perchloride of Iron with 1 oz. of Carbonate of Sodium, or ¼ oz. of Calcined Magnesium, suitably diluted with water: $Fe_2Cl_6 + 6NaHCO_3 = Fe_2 6HO + 6NaCl + 6CO_2$. Half an ounce should be given every 5 or 10 minutes, and the bowels should be quickly cleared by a smart purge of Sulphate of Magnesium or Sodium. Liquor Ferri Dialysatus in doses of 1 fl.oz., diluted with water, is said to be a better antidote. It should be preceded by a dose of common Salt or Bicarbonate of Sodium, and given repeatedly. The solutions of the Persalts are used to arrest hæmorrhage from the stomach. In the duodenum Iron is converted into an alkaline albuminate, and thus absorbed. The further effect of Iron on the bowel is a remote one, to be presently described. The unabsorbed portion escapes as the Sulphide.

2. ACTION ON THE BLOOD, AND ITS USES.

The action of Iron on the blood is almost unique of its kind: first, because its specific action is exerted, not upon the plasma, but upon the red corpuscle, and on this alone, not on any other tissue or organ; secondly, because this action appears to be nothing more than the combination of the Iron as one of the constituent elements of the corpuscle with the others. In the case of no other metal can we speak so definitely of its *modus operandi*.

Iron very slowly enters the circulation along the whole alimentary canal as the chloride and alkaline albuminate, but must unite quickly with the corpuscles, as it cannot long be traced in the plasma. It combines with the hæmoglobin, and in this combination alone it exists in the blood. In healthy subjects a "course" of Iron increases the richness of the blood; whilst in anæmia the rapidity of the growth of corpuscles and of the rise in value of the hæmoglobin, as estimated day by day with the hæmacytometer and hæmoglobinometer, is remarkable.

Iron is accordingly used as a **hæmatinic** in an endless variety of conditions in which hæmoglobin is deficient, such as simple anæmia, scrofula, amenorrhœa, cardiac disease, syphilis, malarial cachexia, and convalescence from acute disease. The cautions already given respecting digestion must be faithfully respected, to secure its hæmatinic action over a length of time. Iron is a constituent of many well-known mineral waters, the most important being those of Spa, Tarasp, Kissingen, Kreuznach, Pyrmont, and St. Moritz on the continent; Tunbridge Wells, Harrogate, and Strathpeffer in this country; the Rawley Springs, Sweet Chalybeate, and Bedford, in the United States. It occurs chiefly as the bicarbonate, held in solution by excess of carbonic acid.

3. SPECIFIC ACTION AND USES.

Iron has no specific action on the organs apart from the blood; and the **tonic** effect which it produces so satisfactorily appears to be entirely referable to its action on the red corpuscles. Abundance of oxygen is essential for every bodily and mental function; and the feeling of "tone," vigour, and mental fitness varies with the degree of oxygenation of the blood, *i.e.* with the quality of the blood as regards hæmoglobin. Nervous, muscular, and cardiac debility are thus removed by Iron, and even digestion is restored by this gastric irritant, if it can be successfully introduced into the blood. The temperature is said to be slightly raised by Iron, showing increased oxydation. Iron has also a specific effect in erysipelas, diphtheria, and other adynamic diseases, which cannot be perfectly explained. Fever is generally held to contra-indicate the use of Iron; and the same may be said of phthisis, except in mild forms or special combinations.

4. REMOTE LOCAL ACTION AND USES.

Iron is excreted by almost every possible channel. As it is absorbed, so a portion of it is excreted along the whole length of the intestine, and colours the fæces black (sulphide). Only a small amount escapes in the urine, saliva, the sweat, the milk, the pancreatic juice, and by the various mucous surfaces. Whilst passing out of the system, Iron produces a second or **remote** effect of an **astringent** kind. As regards the bowels, the clinical applications of this fact are most important. Thus most of the salts of Iron cause constipation unless combined with a purgative, such as the Sulphates of Magnesium and Sodium, or Aloes; no good can be derived from Iron until the bowels have been thoroughly relieved, and are acting regularly; and certain salts, such as the Perchloride and Pernitrate, which are more astringent to the intestines than others, may be employed to check chronic diarrhœa and dysentery, and to arrest hæmorrhage from the bowel in typhoid fever. The remote astringent action of Iron is increased from the fact that it is also excreted by the liver, and passes down with the bile. Passing out sparingly by other channels, *e.g.* the kidneys, Iron must be given in full doses when we desire its action upon them. In the kidneys it is excreted by the cells, not by the glomeruli; the *urine* falls somewhat in volume, but the urea and other solids, as well as the acidity, are increased. Hæmorrhage from the kidneys or bladder is arrested by Iron, which is also beneficial in some cases of Bright's disease. Iron similarly reduces the secretion of *milk* in nursing women. The remote effect of Iron on the *mucous surfaces* renders it a valuable hæmostatic in recurrent passive bleedings from the nose, uterus, and respiratory passages. As a remote astringent, it is invaluable in chronic discharges from the same and allied parts, especially in leucorrhœa.

5. ACTIONS AND USES OF THE DIFFERENT PREPARATIONS OF IRON.

Large as is the number of the preparations of Iron, they and their special actions may be easily remembered if classified as follows:

1. **Iron, its Oxides and Carbonates.**—This group comprises Ferrum Redactum, Mistura Ferri Aromatica, Vinum Ferri, Ferri Carbonas Saccharata, Mistura Ferri Composita, Liquor Ferri Dialysatus, and Ferri Peroxidum Hydratum. These preparations possess the hæmatinic action of Iron with but little astringency, and are accordingly selected to restore the blood when the patient has a tendency to dyspepsia and constipation. They are the principal forms of Iron used in the routine treatment of anæmia, amenorrhœa, and chlorosis in young women. Let it be observed that the solid preparations of this class form soluble compounds in the stomach for absorption into the blood as readily as do the fluid preparations belonging to the second class. The Mistura Ferri Composita, although a preparation of the Protosulphate, contains the Carbonate and Peroxide, and is a favourite and valuable preparation for anæmia with amenorrhœa; the Iron acting as a hæmatinic, the Potassium also building up the red corpuscle (the salts of which are almost entirely Potassium compounds), and the Myrrh increasing the production of leucocytes for conversion possibly into the red, as well as stimulating the uterus. Ferrum Redactum, the Saccharated Carbonate and Hydrated Peroxide, although bulky powders, are easily taken and well borne.

Vinum Ferri is an agreeable preparation largely prescribed for children. The Aromatic Mixture, containing Cinchona and aromatic bitters, is a valuable stomachic tonic and hæmatinic.

2. **Compounds of Iron with the Mineral Acids.**—Ferri Sulphas in its various forms, Liquor Ferri Perchloridi and its preparations, and Liquor Ferri Pernitratis, are comprised in this group, which are characterised by their corrugating and astringent action. They are, therefore, chosen in all the external and internal applications of Iron for local purposes, especially as hæmostatics. The Strong Solution of the Perchloride is injected into the uterus in *post partum* hæmorrhage in the form of a watery solution (1 part to 3) with the best results. Cotton wool or lint soaked in the same solution is used for plugging deep wounds, the cavities of the nose, mouth, etc., in hæmorrhage; but the action of the Iron on the surfaces of wounds, and the extensive coagulation which it sets up in the veins, are both objections to its employment, unless the bleeding cannot otherwise be arrested. Internally these astringent preparations may be given in hæmorrhage from the stomach or bowels, kidneys, or bladder; but not, as a rule, in hæmoptysis. As hæmatinics, the Tincture or Liquor of the Perchloride, and the Pernitrate, well diluted, are much given to convalescents after the appetite has been restored, and to persons who require a tonic; in passive hæmorrhages and chronic inflammatory discharges, such as leucorrhœa; and as a specific in erysipelas. In ordering this class of Iron salts, we must carefully observe the various precautions already mentioned in connection with digestion. Protosulphate is well borne in the form of pill, and is a rapid hæmatinic.

3. **Compounds of Iron with Vegetable Acids.**—These are the Ferri et Ammonii Citras, Ferrum Tartaratum, and the Liquor and Tinctura Ferri Acetatis. They are at once the weakest, the blandest, and the least constipating preparations of Iron, and are therefore employed when only small quantities of the metal have to be given over a length of time as a tonic, or to commence a course of hæmatinics when the alimentary canal cannot tolerate the stronger preparations. They make but little impression upon the more severe forms of anæmia. They can be given with alkalies.

4. **Compounds of Iron with other Active Bodies.**—Iron is combined in the Pharmacopœia with Iodine, Ferri Iodidum; with Arsenic Acid, Ferri Arsenias; with Phosphoric Acid, Ferri Phosphas; and with Quinine, Ferri et Quininæ Citras. Speaking generally, it may be said that in these preparations the Iron is intended to relieve anæmia, or to act as a tonic in the sense we have described, whilst the other constituent is

specifically influencing the diseased condition on which the anæmia or debility depends. Thus the Iodide of Iron is employed in syphilis and scrofula; the Arseniate in chronic diseases of the skin, liver, etc., with a gouty, rheumatic, or malarial taint; the Phosphate in diseases of the bones, such as rickets; and the compound with Quinine in malarial cachexia, where it may rapidly restore the blood corpuscles. But all the preparations of this group, and especially the last, are also used as ordinary tonics, according to circumstances. The Solution of the Persulphate of Iron is introduced solely as a source of several other preparations.

MANGANESIUM. MANGANESE. Mn. 55.

The only salt of this metal in the Pharmacopœia is the Black Oxide; but Permanganate of Potassium, which is derived from it, is best discussed under this head.

Manganesii Oxidum Nigrum.—Black Oxide of Manganese. MnO_2. Native. A heavy black powder.

From Manganesii Oxidum Nigrum is made:

Potassii Permanganas.—Permanganate of Potassium. $KMnO_4$.

Source.—Made by (1) evaporating a mixture of the Black Oxide, Chlorate of Potassium, and a solution of Caustic Potash; pulverising the residue, semifusing, cooling and pulverising; then (2) boiling in water, neutralising the decanted liquor with Carbonic Acid Gas; evaporating, crystallising, and drying. (1) $3MnO_2 + KClO_3 + 6KHO = 3K_2MnO_4 + KCl + 3H_2O$; a manganate being formed. (2) $3K_2MnO_4 + 2H_2O = 2KMnO_4 + 4KHO + MnO_2$; the manganate becoming permanganate by boiling.

Characters.—Dark purple, slender prisms, inodorous, with a sweet astringent taste, yielding a rich purple solution when moistened. *Solubility*, 1 in 16 of water. Is very rapidly deoxydised in the presence of organic matter into hydrated peroxide of manganese, losing its purple colour for a brown. *Impurities.*—Carbonate of Potassium; Black Oxide of Manganese, detected by being less soluble in water, and by volumetric test. *Dose,* 1 to 5 gr.

Preparation.

LIQUOR POTASSII PERMANGANATIS.—1 in 100 of Distilled Water. *Dose*, 2 to 4 fl.dr.

Manganesii Oxidum Nigrum is also used in making Liquor Chlori and Hydrargyri Perchloridum.

GENERAL CHEMICAL CHARACTERS OF MANGANESE SALTS.

Manganese salts give a flesh-coloured precipitate with $(NH_4)_2S$; a white with NH_4HO, partly soluble in excess.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Permanganate of Potassium is an irritant or even caustic in the pure state, stimulant in the form of the Solution, and has a healing effect upon ulcers and wounds. Its principal applications, however, are independent of its physiological action on the human tissues, and due to its influence as an **antiseptic, disinfectant, and deodorant,** that is, to its action on the processes and products of sepsis, fermentation, and decomposition. By its power of giving up oxygen freely, the permanganate either destroys the ferment or organism on which these processes depend, or forms chemical compounds with the materials on which they flourish (the tissues, plasma, pus, etc.), incapable of decomposition; it is thus an *antiseptic.* By similarly oxydising the products of decomposition already begun, it so alters their chemical properties as to deodorise and decolorise them, and it destroys also the power of further infection which such products generally possess; it is thus a *disinfectant.* Permanganate of Potassium may therefore be used as a dressing for foul ulcers; but other substances, possessing special advantages, are generally preferred for this purpose. 1 in 150 is the strength required to destroy bacteria or prevent their reproduction.

Internally.—This salt is employed as a mouth-wash in foul conditions of the teeth and mouth, as a gargle in putrid sore-throat, and as an injection in infective and foul discharges, such as gonorrhœa, vaginitis, ozæna, and cancer of the uterus.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

Nothing is definitely known of the action of Permanganic Acid on the blood, tissues, or organs of excretion. It is difficult to believe that any portion of the salt escapes decomposition before absorption, unless given in poisonous doses; and the Oxide of Manganese, into which it is converted, is believed to be inert, although once considered hæmatinic. The internal administration of the Potassium salt for some supposed effect on infective fevers or gangrenous processes must therefore be useless. It has recently been used as an emmenagogue.

By far the most important application of Permanganate of Potassium is as a disinfectant and deodorant, apart from the human body: to disinfect stools and foul discharges after removal from the patient; to wash utensils; and to flush water-closets, etc. Its great advantages are, that it is rapid and complete in its action; odourless and non-poisonous in solutions of ordinary strength; and that it shows by change of colour whether it is acting or exhausted. The principal disadvantage connected with it is its expense.

SUB-GROUP 3.

HYDRARGYRUM. MERCURY. Hg. 200.

Mercury is of the first therapeutical importance, and a large number of salts and other preparations are made from it, all being derived, directly or indirectly, from the metal itself.

Hydrargyrum.—Mercury. Hg.

Source.—Obtained from Cinnabar, the Sulphide, by roasting or distilling with Lime.

Characters.—A fluid metal, brilliantly lustrous; boils at 662° Fahr. and solidifies at −40° Fahr. *Impurities.*—Lead, tin, etc.; detected by being non-volatile.

Preparations containing free Mercury.

1. **Hydrargyrum cum Cretâ.**—1 in 3, with Prepared Chalk. A light grey powder. *Dose*, 3 to 8 gr.

2. **Emplastrum Hydrargyri.**—1 in 3, with Olive Oil, Sublimed Sulphur, and Lead Plaster.

3. **Emplastrum Ammoniaci cum Hydrargyro.**—1 in 5. See *Ammoniacum.*

4. **Pilula Hydrargyri.** — "Blue Pill." 1 in 3; with Confection of Roses, 1½; and Liquorice, ½. *Dose*, 3 to 8 gr.

5. **Unguentum Hydrargyri.** — "Blue Ointment." 1 in 2, with Lard and Suet.

From Unguentum Hydrargyri are prepared:

a. LINIMENTUM HYDRARGYRI.—1; with Solution of Ammonia, 1; and Camphor Liniment, 1. 1 of Mercury in 6.

b. UNGUENTUM HYDRARGYRI COMPOSITUM. — "Scott's Ointment." 6; with Yellow Wax, 3; Olive Oil, 3; and Camphor, 1½. 1 of Mercury in 4½.

c. SUPPOSITORIA HYDRARGYRI.—5 gr., with 10 gr. of Oil of Theobroma in each. 1 of Mercury in 6.

From Hydrargyrum are made:

6. **Hydrargyri Oxidum Rubrum.**—Red Oxide of Mercury. HgO. "Red Precipitate."

Source.—Made by (1) dissolving Mercury in Nitric Acid; drying; and (2) triturating the resulting Pernitrate with Mercury, and heating. (1) $3Hg + 8HNO_3 = 3(Hg2NO_3) + 2NO + 4H_2O$. (2) $Hg2NO_3 + Hg = 2HgO + 2NO_2$.

Characters.— An orange-red crystalline powder, nearly insoluble in water. Evolves O gas when heated; Hg remaining behind. *Impurities.*—Red lead and brickdust; detected by being non-volatile. Nitrate of mercury; by yielding nitrous vapours by heat. *Dose,* ¼ to 1 gr.; rarely used internally.

Preparation.

UNGUENTUM HYDRARGYRI OXIDI RUBRI. — "Red Precipitate Ointment." 1 in 8, with Hard and Soft Paraffin.

7. **Hydrargyri Persulphas.**—Persulphate of Mercury. $HgSO_4$.

Source.—Made by dissolving Mercury in hot Sulphuric Acid, and drying. $Hg + 2H_2SO_4 = HgSO_4 + 2H_2O + SO_2$.

Characters.—A white, heavy, crystalline powder; rendered yellow by affusion of water; entirely volatilised by heat. Not given medicinally.

From Hydrargyri Persulphas are made:

a. **Hydrargyri Subchloridum.**—Subchloride of Mercury. Calomel. Hg_2Cl_2.

Source. — Made by (1) and (2) triturating a mixture of Persulphate of Mercury, Mercury, and Chloride of Sodium; subliming; and washing with boiling water. (1) $HgSO_4 + Hg = Hg_2SO_4$. (2) $Hg_2SO_4 + 2NaCl = Hg_2Cl_2 + Na_2SO_4$. The Mercury prevents the formation of Perchloride.

Characters.—A dull white, heavy, nearly tasteless powder, insoluble in water, spirit, or ether; boiling concentrated nitric acid oxydises and dissolves it; is blackened by ammonia, dimercurous-ammonium-chloride, (NH_2Hg_2Cl), being formed; entirely volatilised by heat. *Impurities.*—Perchloride of Mercury; soluble in warm ether. Other chlorides; which are not volatile. *Dose,* ½ to 5 gr.

Preparations.

α. LOTIO HYDRARGYRI NIGRA. — Black Wash. Calomel, 1; Lime-Water, 146. $Hg_2Cl_2 + Ca2HO = Hg_2O + CaCl_2 + H_2O$; the Black Oxide being formed.

β. PILULA HYDRARGYRI SUBCHLORIDI COMPOSITA.— Plummer's Pill. Calomel, 1; Sulphurated Antimony, 1; Guaiacum Resin, 2; Castor Oil, 1. *Dose,* 5 to 10 gr.

γ. UNGUENTUM HYDRARGYRI SUBCHLORIDI. —1 in 6½, with Benzoated Lard.

b. **Hydrargyri Perchloridum.**—Perchloride of Mercury. "Corrosive Sublimate." $HgCl_2$.

Source.—Made by triturating a mixture of Persulphate of Mercury, Chloride of Sodium, and Black Oxide of Manganese; and subliming. $HgSO_4 + 2NaCl + MnO_2 = HgCl_2 + Na_2SO_4 + MnO_2$. The Manganese prevents the formation of Calomel, by setting free Cl which converts the Sub- into the Perchloride.

Characters.—Heavy colourless masses of prismatic crystals. *Solubility,* 1 in 20 of water; 1 in 5 of spirit; 1 in 6 of ether. *Incompatible* with alkalies and their carbonates, iodide of potassium, lime-water, tartar-emetic, nitrate of silver, acetate of lead, albumen, soaps, decoction of bark. *Impurities.* —Fixed salts; detected by not volatilising. *Dose,* $\frac{1}{16}$ to ⅛ gr.

Preparations.

α. LIQUOR HYDRARGYRI PERCHLORIDI.—½ gr. in 1 fl.oz. ($\frac{1}{16}$ gr. in 1 fl.dr.) of Water, with ½ gr. of Chloride of Ammonium. Part of the NH_4Cl forms a double salt with $HgCl_2$ and prevents decomposition. *Dose*, 30 to 120 min.

β. LOTIO HYDRARGYRI FLAVA.—"Yellow Wash." Corrosive Sublimate, 1; Lime-Water, 243. $HgCl_2 + Ca(HO)_2 = HgO + CaCl_2 + H_2O$; the Yellow Oxide being formed.

From Hydrargyri Perchloridum are made:

γ. **Hydrargyri Iodidum Rubrum.**—Red Iodide of Mercury. HgI_2.

Source.—Made by mixing hot solutions of Perchloride of Mercury and Iodide of Potassium; and washing and drying the precipitate. $HgCl_2 + 2KI = HgI_2 + 2KCl$.

Characters.—A vermilion crystalline powder. Soluble feebly in water, freely in ether, or in an aqueous solution of Iodide of Potassium. Entirely volatilised by heat under redness. *Impurities*, as of the Perchloride. *Dose*, $\frac{1}{32}$ to ⅛ gr.

Preparations.

i. LIQUOR ARSENII ET HYDRARGYRI IODIDI.—Solution of Iodide of Arsenium and Mercury. Donovan's Solution.

Source.—Made by dissolving by trituration equal parts of Iodide of Arsenium and Red Iodide of Mercury in Water.

Characters. — A clear pale yellow liquid, with a metallic flavour. Contains 1 per cent. of each Iodide. *Dose*, 10 to 30 min.

ii. UNGUENTUM HYDRARGYRI IODIDI RUBRI.—1 in 28 of Simple Ointment.

δ. **Hydrargyrum Ammoniatum.** — Ammoniated Mercury. "White Precipitate." NH_2HgCl.

Source.—Made by precipitating a solution of Perchloride of Mercury with diluted Solution of Ammonia; washing, and drying $HgCl_2 + 2NH_4HO = NH_2HgCl + NH_4Cl + 2H_2O$.

Characters.—An opaque white powder, insoluble in water, spirit, and ether. *Impurities,* as of the Perchloride.

Preparation.

Unguentum Hydrargyri Ammoniati. —1 in 10, with Simple Ointment.

ε. **Hydrargyri Oxidum Flavum.**—Yellow Oxide of Mercury. HgO.

Source.—Made by precipitating a solution of Perchloride of Mercury in water, with Solution of Soda; washing, and drying. $HgCl_2 + 2NaHO = HgO + 2NaCl + H_2O$.

Characters.—A yellow powder; insoluble in water; entirely volatilised by heat. Has the same composition as the Red Oxide, but is non-crystalline.

Preparation.

Oleatum Hydrargyri. — Oleate of Mercury. Yellow Oxide of Mercury, 1; dissolved in Oleic Acid, 9. A light brown, oleaginous, semisolid substance, with a smell of Oleic Acid.

8. **Liquor Hydrargyri Nitratis Acidus.**—Nitrate of Mercury, $Hg2NO_3$, in solution in Nitric Acid.

Source.—Made by dissolving 4 oz. of Mercury in 5 fl.oz. of Nitric Acid and 1½ fl.oz. of Water, and boiling.

Characters.—A colourless, strongly acid liquid; sp. gr. 2·0. *Impurity.*—Subnitrate of Mercury; giving precipitate when dropped into diluted Hydrochloric Acid.

9. **Unguentum Hydrargyri Nitratis.**— "Citrine Ointment." Made by adding a hot Solution of 4 of Mercury in 12 of Nitric Acid, to 15 of Lard melted in 32 of Olive Oil; heating until the mixture froths up; and stirring till cold.

Preparation.

Unguentum Hydrargyri Nitratis Dilutum. —1, with 2 of Soft Paraffin.

Non-official Salt of Mercury.

Hydrargyri Iodidum Viride.—Green Iodide of Mercury. Hg_2I_2. A dull green powder, insoluble in water; becoming yellowish from conversion into the Red Iodide by keeping. *Made* by rubbing together Mercury and Iodine with a few drops of Spirit. *Dose*, 1 to 3 gr.

GENERAL CHEMICAL CHARACTERS OF SALTS OF HYDRARGYRUM.

Solutions of Mercurous salts give a black precipitate with H_2S; and a white precipitate with HCl, blackened by NH_4HO. Those of Mercuric salts give a brown precipitate with H_2S; a scarlet with KI. The insoluble Mercurials are volatilised by heat.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Mercury and most of its preparations cause but little irritation of the unbroken skin unless applied for some time; but all the stronger mercurial preparations are to be used with caution locally. On ulcers and mucous surfaces mercurials produce *four definite effects:* 1. Weak solutions of the Perchloride ($\frac{1}{8}$ to $\frac{1}{4}$ gr. to 1 fl. oz.), and the Ointments of the various salts, are **astringent, antiphlogistic, and stimulant,** like the preparations of other metallic salts. (*See* page 63.) On this principle many inflammations of the skin and eyelids are treated with Red Precipitate, White Precipitate, and Citrine Ointments. 2. Stronger solutions of Corrosive Sublimate cause inflammation of the skin, and concentrated solutions are caustic; but neither effect is employed surgically. The Acid Solution of the Nitrate is also a powerful **caustic,** used to destroy small growths on the skin. 3. All mercurials are **antiseptic and disinfectant,** especially the Perchloride. (*See* page 102.) 4. Part of the application is absorbed, and produces, both locally and generally, the **specific** effect of the metal to be presently described. The official Lotions are intended to have a local specific action, and are much used in syphilis. As it is frequently desirable to obtain the general effects of Mercury by local application, it will be well to describe here the various methods of administration of the drug.

(1) *Inunction.*—In the form of the Ointment, metallic Mercury may be applied by inunction, *i.e.* rubbed into a soft part of the skin. Thus applied, Mercury undoubtedly enters the blood; but it has been contended that the metal is not admitted by the skin, but through the lungs, in the form of the vapour arising from the heated body smeared with the Ointment, or even in small particles by the mouth. Fortunately, the question is of no practical importance, the fact remaining

that the system can be quickly brought under the influence of Mercury by inunction. The Oleate *painted* on the skin also conveys the metal into the system.

(2) *Fumigation.*—The Subchloride (Calomel) may be administered by fumigation. The vapour of Calomel, rising from a vessel heated by a lamp, is conducted to a part or to the whole of the surface of the body of the patient, and there allowed to settle as a fine deposit of the salt. The effect is increased by simultaneous diaphoresis, induced either by the vapour of water or by such a drug as Jaborandi. 20 gr. of Calomel may thus be fumigated, during a sitting of twenty minutes. The same doubt exists as to the precise way in which the Calomel thus applied enters the system.

(3) *Baths.*—As a bath of dilute solutions of the Perchloride, say 3 dr. to 30 gallons of water, with 1 fl.dr. of Hydrochloric Acid.

(4) *Endermically.*—Mercurials may be dusted on to the raw surface of a blistered portion of the skin, or soft syphilitic growths (condylomata), when they are rapidly absorbed.

(5) *Hypodermically.*—Solutions of the Perchloride (albuminates or peptonates) may be injected under the skin or into the tissues; a powerful method, but apt to produce sores.

(6) *Inhalations.*—The vapour of Mercurials may be inhaled, as we have seen; but this method is rarely intentionally employed.

(7) *Per rectum.*—Mercury may be given in the form of suppositories.

Whilst the specific effects of the drug, presently to be described, are developed by these methods, the local effect will be more marked: certain skin diseases will be healed, condylomata removed, and indurations and chronic inflammatory processes in connection with the bones or joints will be reduced.

Internally, the local action of Mercury is the same as externally, according to the nature and strength of the preparation employed. Very dilute solutions of the Perchloride (4 gr. to 10 oz., with 8 min. of Hydrochloric Acid) may be used as a gargle or wash for syphilitic ulcers of the tongue and gums. All the salts of Mercury act upon the mouth, gums, and salivary glands, causing salivation; but this effect is due to their excretion, not to their immediate influence on the parts, and will be described later.

In the stomach, Mercurials combine with the Chloride of Sodium of the secretions, and, whatever their original form, are converted into a double Chloride of Sodium and Mercury, which further unites with the albuminous juices, to form a complex molecule of Mercury, Sodium, Chlorine, and Albumen.

This compound, although precipitated at first, is soluble in an excess either of Chloride of Sodium or of Albumen; exists in the stomach, therefore, in solution; and is readily diffusible and easily absorbed. It is not specially irritant in moderate quantities, and none of the salts of Mercury given in medicinal doses produce vomiting like Zinc and Copper; indeed, Dr. Ringer has shown that Calomel in $\frac{1}{12}$ gr. doses, or Hydrargyrum cum Cretâ in $\frac{1}{3}$ gr. doses, given every two or three hours, arrests some forms of vomiting in children. In large or concentrated doses, however, Mercurials are **irritant** or corrosive to the stomach, and should always be given with caution and after meals.

The irritant effect of Mercurials continues in the duodenum, naturally taking the form of purgation. The Perchloride is never employed to produce this effect, but divided Mercury in the form of the Pilula Hydrargyri or Hydrargyrum cum Cretâ, and Calomel, are common **purgatives.** The action of Mercurials as purgatives is a purely local one, none of the metal being absorbed, but the whole expelled in the fæces. The exact nature of this action is, however, obscure. Probably the intestinal glands are chiefly stimulated to increased secretion, and the mucous membrane irritated to such a degree as to produce a moderate increase of watery exudation from its vessels into the bowel, peristalsis becoming more brisk at the same time. The result is thorough evacuation of the contents of the small intestine, as large, loose, but not watery, stools charged with bile, which has been hurried out directly from the duodenum, and not allowed to re-enter the portal circulation by absorption from the lower bowel, as it normally does. Thus Mercurials, especially Calomel, increase the amount of bile evacuated without *directly* increasing the amount secreted; that is, are **indirect cholagogues** by being duodenal purgatives. The manner in which indirect cholagogue action stimulates the liver to further secretion is discussed on page 475. The purgative action of Mercurials is greatly assisted by a subsequent saline, such as Seidlitz Powder, or the Mistura Sennæ Composita. The class of diseases in which Mercurials are selected as purgatives chiefly include cases of congestion of the portal system and liver, especially those referable to secondary indigestion from free living or gout; cases of constipation attended by irritable stomach, or actual ulceration of the stomach or bowels; very rarely cases of habitual constipation, except at long intervals to enable gentle laxative measures to act more freely; and diarrhœa, when it is distinctly referable to biliary derangement, or the presence of an irritant in the bowel, as in children.

2. ACTION ON THE BLOOD.

As we have seen, Mercury enters the blood freely through the broken or unbroken skin. From the bowel but a small part of a medicinal dose is absorbed, the rest passing off in the fæces as the sulphide, unless combined with Opium, which delays its progress through the intestine. The complex molecule which Mercury forms in the stomach and intestines is decomposed on entering the blood by combination with Oxygen and Albumen, an Oxyalbuminate of Mercury being the result; and apparently the same compound is formed when the metal enters by other channels.

No *direct* effect on the blood can be attributed to Mercury; but an impairment of nutrition generally, including digestion, attends its excessive use, and induces impoverishment both of the plasma and the corpuscles, *indirectly* referable to the drug. The blood under these circumstances is more watery and coagulates less firmly, and nutrition may be further disordered in consequence, with the production of low forms of inflammation and ulceration. But it is to be clearly understood that this is not in any sense a specific effect of Mercury, and that the influence of Mercury upon inflammatory products and syphilitic growths, to be presently described, is not exerted through the blood, but upon the tissues themselves. None of the uses of Mercurials can therefore be referred to under this head, but the impoverishing effect of these drugs upon the blood must be constantly kept in mind, and the quality of the blood sustained by abundance of food, and the strictest attention to digestion. If the appetite fail, or serious dyspepsia arise, Mercurials must at once be stopped.

3. SPECIFIC ACTION.

Mercury quickly leaves the blood and enters the tissues, where it is apt to remain almost indefinitely, being excreted with comparative slowness, especially when the kidneys are diseased. It has been found in every organ of the body, most abundantly in the liver. It is a remarkable fact, however, that no definite anatomical change has ever been demonstrated in the viscera, such as the vessels, liver, or nervous system, even in cases of chronic poisoning by this metal; Mercury in this respect again differing from Lead, Silver, Antimony, and Arsenic. Whilst, therefore, the specific action of Mercury is unquestionable, its *mode* of action is still obscure, and numerous theories have been proposed to account for it, which need not be fully discussed here. The most probable explanation of the effects of Mercury upon nutrition may be said to be that in some way or other it interferes with the growth or life of germinal cells, and that it has therefore an **alterative** influence on certain processes, such as inflammation and syphilis, which are characterised by a growth of small young cells. Possibly, it may have a destructive influence on certain ferments and organisms connected with physiological and pathological metabolism, one of these being the organism of syphilis.

Whatever may be the explanation of its action, Mercury produces a train of symptoms, when given for a considerable period in moderate doses, known as "hydrargyrism," which chiefly take the form of swelling of the gums, salivation, dyspepsia, and diarrhœa; ulceration of the mouth, mucous membranes, and skin; debility; nervous phenomena, including muscular tremors and paralysis, pains, and mental disturbance; cardiac depression; anæmia and cachexia. The temperature is not directly raised, nor are the total excretions more abundant, so that there is no positive evidence of increased metabolism as an effect of Mercury.

4. SPECIFIC USES.

The uses of Mercury as a specific remedy bear no definite relation to these effects, which have been mentioned chiefly that they may be recognised and arrested. The principal application of the drug is as an "alterative" in syphilis, a disease attended by the growth of cells around the small vessels, and the development of these into nodes, gummata, various eruptions, etc. Mercury has a powerful influence in controlling the severity of this disease. Its employment may be commenced with various local applications to the primary sore, and regular internal doses of the Solution of the Perchloride, Calomel, Grey Powder, or some of the other preparations, until salivation threatens. It is generally (not universally) believed that the secondary stage is rendered less severe, or is even entirely prevented, by this means. The drug must be continued during the appearance of secondary symptoms; but, as a rule, it is better omitted in the tertiary stage. The particular preparation employed varies with the experience of the practitioner. Quinine and Opium are useful means of support to be combined with Mercury in a course of the metal, and we must repeat that unless the appetite and digestion continue good its use must be interrupted.

The other use of Mercurials as alterative remedies is in internal inflammations, especially inflammation of serous membranes, such as peritonitis, pericarditis, pleurisy, meningitis, and orchitis. This line of treatment, once universal in England, is now almost obsolete, excepting, perhaps, in peritonitis of a subacute or chronic kind, in which, as in most instances where it is used as an antiphlogistic, Mercury is combined with Opium. Possibly some of the benefit thus attending mercurialisation in inflammation, and which was formerly referred to a "resolvent" action on the fibrin of exudations, is due to its purgative and indirect cholagogue effects.

5. REMOTE LOCAL ACTION AND USES.

Mercury passes out of the system in all the secretions (the saliva, sweat, milk, urine, and bile) probably as an albuminate, and stimulates many of the glands *en route*. It is in this way, as we have seen, a powerful **sialagogue**, causing swelling of the salivary glands and a profuse flow of the secretions of the mouth. This effect is important only because it is to be avoided. The diaphoretic effect of Mercury is comparatively insignificant. Whilst it does not increase of itself the volume of urine, it assists to a marked degree such **diuretics** as Digitalis and Scilla; and it must be given with caution in kidney disease, as it is believed to aggravate inflammation of the tubules, and readily produces its debilitating effects when the renal function is impaired. In the fæces Mercury leaves the body as the sulphide, which is derived, first, from that considerable portion of the dose which is not absorbed; and, secondly, from the portion excreted by the liver (in the bile), and by the pancreas and intestinal glands. It will thus be seen that but little use is made of the remote local action of Mercury.

6. ACTION AND USES OF THE DIFFERENT PREPARATIONS OF MERCURY.

The preparations of Mercury, although so numerous, can be readily remembered, and their special actions understood, when they are classified as follows:

1. *Metallic Mercury* and preparations containing it.
2. The *Perchloride* of *Mercury* and its preparations.
3. The *Subchloride* of *Mercury* and its preparations.
4. The *Oxides*, *Iodides*, *Ammoniated Mercury*, and their preparations: a complex group, the action and uses of which correspond mainly with those of the Perchloride, partly with those of the Subchloride.
5. *Acid Solution of Nitrate of Mercury* and the Ointment.

1. **Metallic Mercury and its preparations.**—These may be employed in all the classes of cases for which Mercurials are adapted. The metal itself is never given internally, except in the finely divided form in which it exists in Pilula Hydrargyri and Hydrargyrum cum Cretâ. The Blue Pill is chiefly used

as a purgative and indirect cholagogue, but is also given in syphilis in small doses combined with Opium and Quinine, and in combination with Digitalis and Scilla as a diuretic (the famous "Guy's Pill"). Hydrargyrum cum Cretâ, "Grey Powder," is a favourite purgative for children, and also a convenient preparation for a course of Mercury in syphilis. Unguentum Hydrargyri, "Blue Ointment," is the usual means of administering the metal by inunction in syphilis. A portion as large as a pea or hazel nut is rubbed daily into a soft part of the skin, such as the inside of the thigh, or smeared on flannel and applied round the loins, the gums being carefully watched. This is a very sure and tolerably safe but very dirty method, which is chiefly employed in infants. Mercurial Ointment may also be smeared over inflamed parts, such as the testis, and is used as a parasiticide. The Liniment of Mercury (the Ointment in a liquid form) is chiefly employed as an antiphlogistic and absorbent, being soaked on lint and applied to the affected part, *e.g.* the joints, or the abdomen in chronic peritonitis. The same use may be made of the Plasters, and of the Compound Ointment, "Scott's Dressing." The Suppository may be used in Syphilis or to kill ascarides.

2. **Perchloride of Mercury.**—This is the most powerful of all Mercurials. It is one of the most active of antiseptics. 1 part in 10,000 destroys micrococci and bacilli; 1 in 1,000 destroys their spores. A solution of the former strength is suitable for an ordinary lotion for wounds; the latter strength may be used to disinfect foul ulcers, especially of syphilitic origin; and a solution of 1 in 500 may be freely employed. It is much used as an antiseptic dressing in combination with cotton wool, wood wool, etc. It is also applied in ringworm. Internally, as the Liquor (a weak solution), it is given in syphilis only, never as a purgative. In this form, the Perchloride is by no means an irritant preparation of Mercury, but rather the reverse. Lotio Hydrargyri Flava, "Yellow Wash," containing the yellow oxide, is applied to syphilitic sores. As a general disinfectant, 1 of the Perchloride in 500 of Water is thoroughly efficient.

3. **Subchloride of Mercury.**—Calomel resembles metallic Mercury in being used externally and internally as a purgative, alterative, and antisyphilitic remedy. Externally it is applied to syphilitic sores and chronic inflammatory growths as Calomel dust, by fumigation, as the Unguentum, and as the Black Wash. Internally, Calomel is a valuable purgative, very readily taken, and easily borne even in irritable states of the stomach, with the powerful action as an indirect cholagogue and hepatic stimulant already described. The Compound Calomel Pill (Plummer's Pill) is in much repute as a hepatic

stimulant and alterative, with little or no directly purgative effect, given every night or every other night, for a week at a time, in gout and loaded conditions of the system consequent on free living. Calomel combined with Opium was the favourite Mercurial employed by the last generation of surgeons and physicians in the treatment of inflammation, to which we have already referred. In syphilis the same combination is still employed with success.

4. **The Oxides, Iodides, and Ammonio-Chloride of Mercury.**—These substances, although forming a convenient group, belong, as regard their action and uses, chiefly to the second class named. Thus the following closely resemble the Perchloride, viz. Hydrargyri Oxidum Flavum, Hydrargyri Oxidum Rubrum, Hydrargyri Iodidum Rubrum, and Hydrargyrum Ammoniatum. The first two are chiefly used externally in syphilis and chronic inflammations of the skin and eyes. The Oleate is used in syphilis and inveterate ringworm. The "White Precipitate" Ointment is useful as a parasiticide, and as a stimulant application to chronic inflammatory eruptions in children. With the Subchloride may be classed the Green Iodide, no longer official because so unstable and therefore dangerous, but much used by some surgeons. The student will not forget that the Lotio Hydrargyri Flava really contains the Yellow Oxide, and the Lotio Hydrargyri Nigra the Black Oxide, although they are reckoned preparations of the Perchloride and Subchloride respectively. Donovan's Solution is valuable in obstinate syphilides.

5. **Liquor Hydrargyri Nitratis Acidus, and the Ointment of the Nitrate.**—These are not used in syphilis. The former is applied as a caustic in lupus and other limited growths and ulcers of the skin; the Ointment as a stimulant to chronic skin diseases, and to the edges of the eyelids in chronic inflammation and ulceration of the hair follicles.

Precautions in the use of Mercurials.—Mercury must not be given as an alterative, antiphlogistic, or antisyphilitic remedy in persons with anæmia or debility, unless these are distinctly referable to syphilis, and even then it must be employed with caution. This remark also applies to tuberculosis and kidney disease; and certain individuals will occasionally be met with in whom even small doses of Calomel or Blue Pill quickly induce hydrargyrism by a kind of idiosyncrasy. In every instance the patient must be carefully nourished, as we have said. On the contrary, children, even infants, bear Mercury very well, although the prolonged administration of the metal to them appears to produce a peculiar change in the permanent teeth when they appear, which is extremely unsightly (mercurial teeth of Hutchinson).

SUB-GROUP 4.

PHOSPHORUS, ARSENIUM, ANTIMONIUM, BISMUTHUM.

PHOSPHORUS. PHOSPHORUS. P. 31.

Under this head will be described not only the element itself, but the Hypophosphites, which are derived from it, and are believed to be closely related to it pharmacologically.

Phosphorus.—A non-metallic element obtained from Bones.

Source.—Made by (1) treating Bone-ash with Sulphuric Acid and Water; filtering and evaporating; (2) heating the product with Charcoal; and distilling. (1) $Ca_32PO_4 + 2H_2SO_4 = CaH_42PO_4$ (Acid Phosphate) $+ 2CaSO_4$. (2) $CaH_4 2PO_4 = Ca2PO_3$ (Metaphosphate) $+ 2H_2O$. (3) $3(Ca2PO_3) + C_{10} = P_4 + Ca_32PO_4 + 10CO$.

Characters.—A semi-transparent, almost colourless, wax-like solid, when fresh; luminous in the dark, ignites in the air; insoluble in water, soluble in ether, oils, and naphtha.

Preparations.

1. OLEUM PHOSPHORATUM.—Phosphorated Oil.

Source. —Made by dissolving 4 gr. of Phosphorus in 1 fl.oz. of Almond Oil at 180° Fah. *Dose*, 2 to 5 min.

2. PILULA PHOSPHORI.—1; with Balsam of Tolu, 40; Yellow Wax, 19; and Curd Soap, 30. *Dose*, 2 to 4 gr. $= \frac{1}{45}$ to $\frac{1}{22.5}$ gr. of Phosphorus.

From Phosphorus is made:

3. **Calcii Hypophosphis.** $Ca(PH_2O_2)_2$.

Source.—Made by heating Slaked Lime and Water with Phosphorus; purifying the liquid; and crystallising. $3CaH_2O_2 + 2P_4 + 6H_2O = 3Ca(PH_2O_2)_2 + 2PH_3$.

Characters.—White pearly crystals, with a bitter nauseous taste. *Solubility*, 1 in 8 of cold water; insoluble in spirit. *Dose*, 1 to 5 gr.

Calcii Hypophosphis is used in making:

Sodii Hypophosphis. $NaPH_2O_2$.

Source. — Prepared by adding Carbonate of Sodium to a solution of Hypophosphite of Calcium, and evaporating the filtrate to dryness. $Ca2PH_2O_2 + Na_2CO_3 = 2NaPH_2O_2 + CaCO_3$.

Characters.—A white, granular, deliquescent salt, with a bitter nauseous taste. *Solubility,* 1 in 2 of water; sparingly in spirit. *Dose,* 1 to 5 gr.

Phosphorus is also used in making:

Acidum Phosphoricum Concentratum.

GENERAL CHEMICAL CHARACTERS OF PHOSPHORUS AND HYPOPHOSPHITES.

Phosphorus is luminous when opened in a dark place. *Hypophosphites* give a black precipitate with $AgNO_3$; a grey with $HgCl_2$. With Zn and H_2SO_4 they yield PH_3. Acid solutions decolorise $KMnO_4$.

ACTION AND USES.

Phosphorus has a powerful action on the body, and one which has been proved by elaborate investigations on animals to be of the most interesting kind to the physiologist. As a poison Phosphorus is also of great importance. Unfortunately, however, it cannot be said to be of much value to the therapeutist, as it has disappointed most attempts to turn it to practical account in the treatment of disease.

1. IMMEDIATE LOCAL ACTION.

Externally and internally Phosphorus acts as a powerful local **irritant and caustic**, but is never given to produce this effect. For the same reason the drug must not be ordered in the solid form, but carefully mixed with oil or fat.

2. ACTION ON THE BLOOD, AND ITS USES.

Phosphorus enters the blood, and may be found in it partly unchanged, partly oxydised into Phosphorous or Phosphoric Acid at the expense of the oxygen of the red corpuscles. The specific effects to be presently described cannot, however, be accounted for by interference with the oxygenating function of the blood. Phosphorus has been employed in leukæmia and lymphadenoma, but on the whole with disappointing results.

3. SPECIFIC ACTION AND USES.

In the tissues Phosphorus may be traced as the uncombined element; another proof that its oxydation in the blood is incomplete. Its effect on metabolism, when given in large doses, is most distinct and definite. It increases the nitrogenous products, including urea, tyrosin, and leucin; reduces the glycogen of the liver to *nil;* raises the temperature; diminishes the excretion of carbonic acid, and the volume of oxygen absorbed; and leads to fatty degeneration of epithelial, glandular and muscular protoplasm throughout the body. No doubt these **alterative** effects are essentially associated with each other; Phosphorus, whilst increasing metabolism, so influencing it as to diminish oxydation, and thus to arrest the process at the first stage where proteids are converted into urea and oil, instead of allowing it to proceed to the second and final stage, where the oil is further oxydised into carbonic acid and water. Hence all the results just enumerated: whilst the soluble products (urea, etc.) are excreted, the insoluble products (oils or fats) are retained in the tissues, constituting fatty degeneration.

The uses to which Phosphorus has been put as a specific remedy do not obviously depend on these effects upon nutrition. It has been given in nervous disorders, such as neuralgia; in adynamic conditions, such as typhoid fever; in some kinds of skin diseases, including pemphigus; and as an aphrodisiac. It is difficult to understand how any of these morbid states can be benefited by a substance which diminishes oxydation; and, indeed, the empirical use of Phosphorus has recently been in a great measure abandoned.

In very small doses over a considerable length of time, Phosphorus affects the structure of bones, converting the spongy portion into firm, compact substance, without in any way altering its composition chemically. It has therefore been recommended in rickets and for ununited fracture; but in rickets, at least, is far inferior to certain other medicinal measures.

Hypophosphites of Sodium and Calcium.—The Hypophosphites have recently been much employed in cases of nervous and general debility, and chronic lung disease; and act, according to some authorities, in the same manner as free Phosphorus, without being irritant. As the Hypophosphites are probably converted into phosphates in the stomach, they may be expected to stimulate the liver and bowels, and to affect the growth and healing of bones, lymphatic glands, and adenoid tissue, including tubercle.

4. REMOTE LOCAL ACTION.

Phosphorus is excreted by the kidneys as Phosphorus and Phosphorous Acid, not as phosphates. It is not employed in this connection.

ARSENIUM. ARSENIUM. As. 75.

All the preparations of this metal are derived from White Arsenic.

Acidum Arseniosum.—Arsenious Acid. White Arsenic. As_2O_3.

Source.—An anhydride (not a true acid), obtained by roasting arsenical ores, and purified by sublimation.

Characters.—A heavy white powder; or stratified, opaque, white porcelain-like masses. *Solubility*, 1 in 100 of cold, 1 in 20 of boiling water. Volatilised by heat of 400° Fahr. *Incompatibles.*—Salts of iron, magnesia, lime-water. *Impurities.*—Lime salts; non-volatile. *Dose*, $\frac{1}{60}$ to $\frac{1}{12}$ gr. in solution.

Preparations.

1. **Liquor Arsenicalis.**—"Fowler's Solution."

Source.—Made by boiling Arsenious Acid and Carbonate of Potassium in Water; and colouring with Compound Tincture of Lavender. 1 in 100. It is doubtful whether any decomposition occurs.

Characters.—A reddish liquid, alkaline to test-paper, with the odour of lavender. *Dose*, 2 to 8 min.

2. **Liquor Arsenici Hydrochloricus.**—Hydrochloric Solution of Arsenic.

Source.—Made by boiling Arsenious Acid with Hydrochloric Acid and Water. 1 in 100. No decomposition occurs. *Characters.*—Colourless, with an acid reaction. *Dose*, 2 to 8 min.

From Acidum Arseniosum is made:

3. **Sodii Arsenias.**—Arseniate of Sodium. $Na_2HAsO_4,12H_2O$; and $Na_2HAsO_4,7H_2O$.

Source.—Made by (1) fusing Arsenious Acid with Nitrate and Dried Carbonate of Sodium; (2) boiling the product in Water; and crystallising. (1) $As_2O_3 + 2NaNO_3 + Na_2CO_3 = Na_4As_2O_7$ (Pyro-Arseniate of Sodium) $+ N_2O_3 + CO_2$. (2) $Na_4As_2O_7 + 15H_2O = 2(Na_2HAsO_4,7H_2O)$.

Characters.—Colourless transparent prisms. *Solubility*, 1 in 2 of water. The solution is alkaline. Heated to 300° Fahr., it loses 53·73 per cent. of its weight. *Dose*, $\frac{1}{16}$ to $\frac{1}{8}$ gr.

Preparation.

LIQUOR SODII ARSENIATIS.—1, dried at 300° Fahr., in 100 of Distilled Water. *Dose*, 5 to 10 min.

From Arseniate of Sodium is made :

Ferri Arsenias. See *Ferrum.*

4. **Arsenii Iodidum.**—Iodide of Arsenium. AsI_3.

Source.—Made by the direct combination of Iodine and metallic Arsenium; or by evaporating to dryness an aqueous mixture of Arsenious and Hydriodic Acids.

Characters.—Small orange-coloured crystals, readily and almost entirely soluble in water and in spirit. Aqueous solution neutral. *Dose,* $\frac{1}{30}$ gr.

Preparation.

LIQUOR ARSENII ET HYDRARGYRI IODIDI.—Donovan's Solution. See *Hydrargyrum,* page 94.

GENERAL CHEMICAL CHARACTERS OF SALTS OF ARSENIUM.

Arsenic volatilises by heat, emitting the odour of garlic. It also gives Marsh's and Reinsch's tests. Acid arsenical solutions give a yellow precipitate with H_2S; Arseniates give a chocolate precipitate with $AgNO_3$.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Arsenious Acid is irritant, **caustic**, and antiseptic. It is used occasionally to destroy lupus, epithelioma, and other superficial or limited new growths, in the form of a "paste," composed of Arsenious Acid 1, Charcoal 1, Red Sulphuret of Mercury 4, and Water. In the form of a dilute ointment, it is employed in psoriasis to remove the scaly growth. Arsenic must be used locally with great care, as it is absorbed from the broken skin, ulcers, and mucous membranes, unless sufficient inflammation be set up to throw it off.

Internally.—The local corrosive action of Arsenic may be employed in caries of the teeth to destroy the painful pulp before stopping, a paste composed of 2 parts of Arsenious Acid, 1 part of Sulphate of Morphine, and a sufficiency of Creasote to make a stiff compound, being placed in the cavity.

Reaching the stomach in medicinal doses, the preparations of Arsenic do not combine with the albuminous contents like Mercury, but remain unchanged. They thus act upon the mucous membrane, stimulating the nerves and vessels, causing a sense of heat and hunger, and increasing the gastric functions. In these small doses Arsenic is employed with advantage in some cases of gastric dyspepsia; and a similar effect on the duodenum makes it of some value in lienteric diarrhœa. If the dose be increased, the stimulant action may readily pass into **irritation of the stomach**, attended by pain and sickness, and diarrhœa from intestinal excitement. These symptoms, which we shall find to be partly due to the excretion of the metal, are to be remembered only that they may be avoided, or arrested if they should arise.

2. ACTION IN THE BLOOD, AND ITS USES.

Arsenic quickly enters the blood, but produces no effect upon it except as a consequence of its specific action on the tissues, presently to be described. It has been used with success in some forms of anæmia; but less frequently in idiopathic cases than where the corpuscles and plasma have suffered from failure of nutrition elsewhere (symptomatic anæmia), as in tuberculosis, malaria, gout, and rheumatism. Alone or combined with Iron, it has sometimes an excellent effect in restoring the blood in such cases.

3. SPECIFIC ACTION AND USES.

Arsenic enters all the organs and tissues, but is not known to combine with their albuminous constituents; it remains in them for a short time only; and is quickly excreted. During this period, however, it distinctly influences metabolism; according to Binz, by alternate oxydation of Arsenious into Arsenic Acid at the expense of the protoplasm, and reduction of the higher Acid again into the lower by the venous and capillary blood. It first reaches the liver, and reduces the amount of glycogen in it, so that it may be occasionally, but by no means often, used with success in diabetes. In the other organs it interferes similarly with metabolism, apparently (like Phosphorus) through the oxygenating process. An increased amount of nitrogenous waste appears in the urine; the temperature rises; and the excessive fatty product of the albuminous decomposition remains unexcreted, constituting fatty degeneration. Short of this effect, Arsenic appears to produce a wholesome increase of the metabolism or vital activity of all the organs; and it is perhaps in this way that the drug acts as a general **tonic**, and as a valuable **alterative** in such classes of disturbed nutrition as gout and chronic rheumatism. For the same reason it hastens the degeneration and absorption of inflammatory products in catarrhal pneumonia and phthisis. It is possible, however, that Arsenic affects the life processes of other living particles in the body besides the tissue elements, namely, the organisms of certain diseases. It is, next to Quinine, the most successful medicinal agent in the treatment of chronic malaria, brow-ague and other varieties of neuralgia due to the same cause, and malarial cachexia; and it is used with advantage in hay-fever. It sometimes dispels lymphomatous tumours. Beyond a safe amount, Arsenic produces a series of nutritive disorders in the tissues, characterised chiefly by debility and nervous disturbances, known as "chronic arsenical poisoning," which need not be detailed here.

Next to nutrition generally, the nervous system appears to be most influenced by Arsenic, which is found abundantly in the grey matter of the cord in poisoning by this metal. Here it acts by diminishing the sensibility and reflex irritability of the centres; the motor nerves and muscles are affected later. Preparations of Arsenic are useful in chorea, various forms of neuralgia, and spasmodic asthma, especially when malaria or anæmia, or both, may happen to be associated with the neurosis. Like Phosphorus, Arsenic increases the compact tissue of bone at the expense of the medullary tissue, but it is not specially used to produce this effect. In large doses it has a depressing effect on the respiration, circulation, and temperature.

4. REMOTE LOCAL ACTION AND USES.

Arsenic is excreted chiefly in the urine in the form of arsenious acid; also by the gastro-intestinal mucosa, the liver, and skin. It is not known to affect the kidney specially, but is sometimes used in chronic Bright's disease. The gastro-enteric irritation, set up by over-doses of Arsenic, appears to be chiefly produced during the excretion of the metal, not as an immediate local effect. The liver, as we have seen, is modified in its activity; and part of the value of Arsenic in chronic gout, gravel, and skin diseases, may be referable to its action on the greatest metabolic organ in the body. Either indirectly, or directly, its effect on the skin is very marked. It is the most valuable of all internal remedies for certain eruptions obviously connected with disordered nutrition, such as psoriasis, chronic (not *acute*) eczema, acne, and pemphigus; whilst it occasionally causes herpes, and aggravates erythema multiforme. Donovan's Solution is used in syphilides. Arseniate of Iron checks night sweats in phthisis.

5. METHODS OF ADMINISTERING ARSENIC, AND PRECAUTIONS IN ITS USE.

Arsenical preparations should always be given immediately at the end of meals, unless its gastric effect be distinctly desired, which is rarely the case; and it ought not to come into free contact with the exposed mucous membrane. For the same reason it must not be given in alterative doses if dyspepsia be present. Epigastric fulness, pain and tenderness, a sense of constriction in the throat, irritation or soreness of the conjunctivæ, and especially vomiting, ought to suggest a diminution or suspension of the drug. Children bear Arsenic with comparative ease, whilst old subjects are said to bear it badly. A combination of Iron with Arsenic (for example, Vinum Ferri with Liquor Arsenicalis) is one of the best of hæmatinics and tonics, probably because the Iron affords a supply of oxygen sufficient to carry the increased metabolism produced by the Arsenic to a complete termination. Weight for weight of the metal, the Arseniates are less active than the Arsenites.

ANTIMONIUM. ANTIMONY. Sb. 122.

The metal itself (Stibium) is not official, all the preparations being derived from Black Antimony, as follows :

Antimonium Nigrum Purificatum.—Purified Black Antimony.

Source.—Native Sulphide of Antimony, Sb_2S_3, purified from siliceous matter by fusion and powdering; and from Arsenic by maceration with Solution of Ammonia, and washing.

Characters.—A greyish-black crystalline powder; soluble almost entirely in boiling hydrochloric acid. *Impurity.*—Silica; insoluble in boiling HCl.

From Antimonium Nigrum Purificatum are made :

1. **Antimonium Sulphuratum.**—Sulphurated Antimony. A mixture containing Sulphide of Antimony, Sb_2S_5, and Oxide of Antimony, Sb_2O_3, or Sb_2O_5.

Source.—Made by (1) boiling Black Antimony with Sublimed Sulphur and Solution of Soda; diluting with water; and (2) precipitating with Diluted Sulphuric Acid, washing, and drying. (1) $2Sb_2S_3 + 6NaHO + 2S_2 = 2Na_3SbS_4 + Sb_2O_5 + H_2O + 2H_2S$. (2) $2Na_3SbS_4 + 3H_2SO_4 = Sb_2S_5 + 3Na_2SO_4 + 3H_2S$.

Characters.—An orange-red powder, without odour, and with a slight taste. Insoluble in water; soluble in HCl with evolution of H_2S, the solution yielding a white precipitate with water. *Impurities.*—General; detected volumetrically. *Dose,* 1 to 5 gr.

Antimonium Sulphuratum is contained in Pilula Hydrargyri Subchloridi Composita—about 1 in 5. See *Hydrargyrum,* page 93.

2. **Liquor Antimonii Chloridi.**—Solution of Chloride of Antimony, $SbCl_3$, in Hydrochloric Acid.

Source.—Made by dissolving Purified Black Antimony in Hydrochloric Acid. $Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S$.

Characters.—A heavy liquid, colourless when pure; giving a white precipitate when dropped into water.

From Liquor Antimonii Chloridi is made :

Antimonii Oxidum. — Oxide of Antimony. Sb_2O_3.

Source.—Made by (1) precipitating Oxychloride of Antimony, by pouring the Solution of the Chloride into Water; washing; and (2) adding Carbonate of Sodium solution, washing, and drying. (1) $12SbCl_3 + 15H_2O = 2SbCl_3 5Sb_2O_3 + 30HCl$. (2) $2SbCl_3 5Sb_2O_3 + 3Na_2CO_3 = 6Sb_2O_3 + 6NaCl + 3CO_2$.

Characters.—A greyish-white powder, insoluble in water. *Impurities.* — Higher oxides, insoluble when boiled with acid tartrate of potassium. *Dose,* 1 to 4 gr.

Preparation.

PULVIS ANTIMONIALIS —A substitute for "James's Powder." 1, with 2 of Phosphate of Calcium. *Dose,* 3 to 5 gr.

From Antimonii Oxidum is made :

Antimonium Tartaratum. — Tartarated Antimony. Tartar Emetic. $KSbOC_4H_4O_6, H_2O$. An Oxytartrate of Antimony and Potassium.

Source.—Made by preparing a paste of Oxide of Antimony and Acid Tartrate of Potassium with Water; letting it stand for 24 hours; boiling in water, evaporating, and crystallising. $2KHC_4H_4O_6 + Sb_2O_3 = 2KSbOC_4H_4O_6 + H_2O$.

Characters.—Colourless transparent crystals, exhibiting triangular facets. *Solubility,* 1 in 20 of cold, 1 in 2 of boiling water; slightly in proof spirit. Solution is faintly acid. *Incompatibles.*—Gallic and tannic acids, most astringent infusions, alkalies, lead salts. *Impurities.*—Cream of tartar, detected volumetrically and by solubility. *Dose.*—As a diaphoretic, $\frac{1}{16}$ to $\frac{1}{6}$ gr.; as a depressant, $\frac{1}{6}$ to 1 gr.; as an emetic, 1 to 2 gr.

Preparations.

α. UNGUENTUM ANTIMONII TARTARATI. 1, to 4 of Simple Ointment.

β. VINUM ANTIMONIALE.—2 gr. in 1 fl.oz. of Sherry. *Dose,* 5 min. to 1 fl.dr.

GENERAL CHEMICAL CHARACTERS OF ANTIMONIUM SALTS.

Salts of Antimonium give an orange precipitate with H_2S, and can be detected by Marsh's and Reinsch's tests.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Antimony, in the form of the Liquor Antimonii Chloridi, is an **escharotic**, employed chiefly in veterinary practice, occasionally by the surgeon as an application to poisoned, foul, or malignant surfaces. Tartarated Antimony applied to the skin, either in aqueous solution or as the official Ointment (half a drachm at a time, repeated), causes a pustular eruption, and was once used as a **counter-irritant** in diseases of the lungs, joints, or meninges. Antimony is freely absorbed from the broken skin, and from mucous surfaces.

Internally, the local effect is equally irritant. In doses of 1 to 3 grains Tartarated Antimony is an **emetic**, whence its popular name. The effect is partly direct, due, that is, to the irritant action of the drug upon the walls of the stomach; partly indirect, from immediate stimulation of the vomiting centre in the medulla. Further, its direct effect on the stomach is produced not only when the salt is admitted to it by the mouth, but after it reaches the stomach by the blood, that is, when it is being excreted by the gastric mucosa. Thus, whilst Tartar Emetic induces vomiting most quickly when swallowed, it is not speedy and evanescent in its effects, but causes both previous and subsequent nausea and depression. It is not suited, therefore, for use in cases of poisoning, where rapid evacuation is of the first importance, or where there is much general depression; but in the first stage of acute inflammatory diseases, with sthenic fever in strong healthy subjects. It is especially indicated in respiratory affections, such as laryngitis and bronchitis, where its remote effects as an expectorant are valuable; or to clear the air passages in the same diseases or in whooping cough.

In smaller continued doses the local action of Tartarated Antimony on the stomach and bowels is apt to produce loss of appetite, nausea, pain, and diarrhœa.

2. ACTION IN THE BLOOD.

Antimony enters the blood either from within or from without, but does not appear to combine with the albumen of the plasma. No special action or use has to be mentioned under this head.

3. SPECIFIC ACTION AND USES.

Having reached the tissues and organs, Antimony clings to them with some tenacity, and may be found in them months after its administration. Here it sets up a series of important changes, attended by phenomena referable to the general nutrition of the body, to the circulation, respiration, and nervous and muscular systems; besides the effects to be afterwards described as referable to its excretion.

The effect of Antimony on *metabolism* closely resembles that of Phosphorus and Arsenic, to the account of which the student is referred. Briefly, the principal results are fatty degeneration of the organs and increase of the nitrogenous products, oxygenation being comparatively deficient. Upon this **alterative** effect depends in part the value of Antimony in gout, chronic skin diseases, etc., to be afterwards described. The circulation is depressed from the first by Tartarated Antimony. Even in small doses it reduces the strength, and very soon the frequency of the pulse, which tends to become irregular, whilst fainting may occur; these effects being due to the action of the drug, first, upon the heart (partly directly on its nervo-muscular substance, partly reflexly from the stomach); and, secondly, upon the vessel walls. Antimony is thus a powerful **circulatory depressant.** The *respiratory* movements are also weakened and disturbed by this drug, which causes shortness of inspiration and lengthening of expiration, manifestly a minor degree of the disturbance which culminates in vomiting, and allied to the process of expectoration. The *nervous system* is markedly depressed by Antimony, in part directly, in part indirectly through the circulation, the effect of a moderate dose being to produce a sense of languor, inaptitude for mental exertion, lowness, and sleepiness. Tartarated Antimony has accordingly been used as a **sedative** in the delirium and insomnia of fevers, such as typhus, and in acute alcoholism (delirium tremens), combined with Opium in various proportions.

The *muscular system* is so powerfully depressed by Antimony that, before the introduction of Chloroform, it was employed to produce muscular relaxation in the reduction of herniæ and dislocations. Nauseating and emetic doses cause great weakness of the voluntary movements, inability to stand, occasional tremors, and aching of the muscles. Tartar Emetic is still given as an **antispasmodic**, to relax the cervix uteri in some classes of difficult labour, and in combination with purgative medicines to prevent or remove spasm of the bowel.

4. REMOTE LOCAL ACTION AND USES.

Antimony leaves the system by all the mucous surfaces, the liver, kidneys, and skin; so that it may cause inflammation, salivation, and pustulation of the mouth, œsophagus and stomach, even when administered by the skin. In being excreted by the *stomach*, it produces there, as we have seen, a remote emetic effect. Its excretion in the *bile* constitutes it a hepatic stimulant; Sulphurated Antimony, either as Plummer's Pill or alone, being much esteemed as a **cholagogue**, especially in gout and loaded conditions of the liver. In passing through the *kidneys* it has a slight diuretic action. In doses of $\frac{1}{10}$ to $\frac{1}{5}$ gr., Tartarated Antimony stimulates the skin, acting as a diaphoretic, of service in feverish conditions. Its internal use occasionally develops the characteristic pustular eruption, which suggests it as a remedy for certain kinds of chronic skin disease. Antimonial Wine is a familiar **sedative expectorant**, apparently from the excretion of the drug by tho respiratory surfaces. It is given with great advantage in the first stage of acute bronchitis in strong subjects, in asthma, in hæmoptysis, and with special care at the commencement of acute pneumonia.

5. USES OF THE COMBINED ACTIONS OF ANTIMONY.

When the various effects of Antimony thus detailed are reviewed together, it is found to be a powerful general depressant, oxygenation being impaired, nervo-muscular activity reduced, the heart weakened, and the waste of the body increased through all the channels of excretion and by loss of heat. When a full dose (1 to 3 gr. of Tartarated Antimony) is given, and vomiting induced, this genoral depression may threaten to pass into collapse, with pallor and coldness of the surface, and marked fall of the body temperature. On this account it may sometimes be employed with benefit as an **antipyretic** or febrifuge at the commencement of acute febrile attacks in sound robust subjects, more especially in bronchitis, where the attendant increase of the bronchial secretion will be serviceable, and the possible emesis by no means contra-indicated. Caution must be exercised in prescribing this powerful depressant, and the best method of administering it is in doses of $\frac{1}{16}$ to $\frac{1}{8}$ gr. in water every 15 or 30 minutes, or of $\frac{1}{4}$ to $\frac{1}{2}$ gr. every three hours, until the skin becomes moist and cool.

The unquestionable value of Plummer's Pill would appear to be partly referable in the same way to the action of Antimony not only on nutrition, but on the various organs of elimination, including the skin and the kidneys.

BISMUTHUM. Bismuth. Bi. 210.

All the salts and preparations of Bismuth are derived from the metal.

Bismuthum.—Bismuth. A crystalline metal. In its crude state it is impure.

From Bismuthum is made:

Bismuthum Purificatum.—Purified Bismuth.

Source.—Made by melting Bismuth, heating it with Cyanide of Potassium and Sulphur, and cooling; again heating with a mixture of dried Carbonates of Potassium and Sodium, cooling, and pouring into moulds.

Characters.—A crystalline metal, of a greyish-white colour, with a roseate tinge. *Impurities.*—Arsenium and other metals.

From Bismuthum Purificatum are made:

1. **Bismuthi Carbonas.**—Carbonate of Bismuth. $2(Bi_2O_2CO_3),H_2O$.

Source.—Made by (1) dissolving Purified Bismuth in Nitric Acid and Water; and (2) precipitating by a solution of Carbonate of Ammonium. (1) $Bi_2 + 8HNO_3 = 2(Bi3NO_3) + 2NO + 4H_2O$. (2) $4(Bi3NO_3) + 4(N_3H_{11}C_2O_5) + 2H_2O = 2Bi_2O_2CO_3 + 6CO_2 + 12NH_4NO_3$.

Characters.—A white powder; insoluble in water, soluble with effervescence in Nitric Acid. *Impurities.*— The Subnitrate and its impurities. *Dose*, 5 to 20 gr.

2. **Bismuthi Subnitras.**—Subnitrate of Bismuth. An oxynitrate. $BiONO_3,H_2O$.

Source.—Made by (1) dissolving Purified Bismuth in diluted Nitric Acid; heating; concentrating; and (2) pouring the product into Water, washing and drying. (1) $Bi_2 + 8HNO_3 = 2(Bi3NO_3) + 2NO + 4H_2O$. (2) $Bi3NO_3 + H_2O = BiONO_3 + 2HNO_3$.

Characters.—A heavy white powder, in minute crystalline scales; insoluble in water; acid. *Impurities.*—Arsenic and chlorides. *Dose,* 5 to 20 gr.

Preparation.

a. TROCHISCI BISMUTHI.—2 gr. Subnitrate of Bismuth, with Carbonate of Calcium, Carbonate of Magnesium, and the usual ingredients of a lozenge, in each. *Dose,* 1 to 6.

From Bismuthi Subnitras are made:

b. **Bismuthi Citras.**—$BiC_6H_5O_7$.

Source.—Made by (1) dissolving Subnitrate of Bismuth in Nitric Acid, and mixing with water; and (2) precipitating with a fresh solution of Citrate of Sodium, and boiling; filtering when cold, washing and drying. (1) $BiONO_3 + 2HNO_3 = Bi3NO_3 + H_2O$. (2) $Bi3NO_3 + Na_3C_6H_5O_7 = BiC_6H_5O_7 + 3NaNO_3$.

Characters.—A white powder, usually containing 2½ per cent. of absorbed moisture. Soluble in Solution of Ammonia. *Dose,* 2 to 5 gr.

Preparation.

LIQUOR BISMUTHI ET AMMONII CITRATIS.—Made by dissolving 800 gr. in Solution of Ammonia (until the salt is just dissolved), and diluting with Water to 1 pint. *Dose,* ½ to 1 fl.dr.

From Liquor Bismuthi et Ammonii Citratis is made:

Bismuthi et Ammonii Citras.

Source.—Made by evaporating Solution of Citrate of Bismuth and Ammonium to a syrupy consistence, and drying on porcelain plates.

Characters.—Small shining translucent scales, with a slightly metallic taste; very soluble in water. *Dose*, 2 to 5 gr.

c. **Bismuthi Oxidum.**—Oxide of Bismuth. Bi_2O_3.

Source.—Made by boiling Subnitrate of Bismuth in Solution of Soda; and washing and drying the precipitate. $2BiONO_3 + 2NaHO = Bi_2O_3 + 2NaNO_3 + H_2O$.

Characters.—A dull lemon-yellow powder, insoluble in water, soluble in Nitric Acid mixed with half its volume of water. *Impurities*, as of the Subnitrate. *Dose*, 5 to 15 gr.

GENERAL CHEMICAL CHARACTERS OF BISMUTH SALTS.

Solutions of the Nitrate or Chloride give a white precipitate when thrown into water; and this is blackened by H_2S.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, applied in the form of powder or ointment, Subnitrate of Bismuth acts only physically on the unbroken skin, protecting it from the irritation of air and dirt. If the surface be inflamed, as in chapped hands, chapped nipples, irritable ulcers, and eczema, it is a mild **sedative and astringent**, soothing and drying up the part. Accessible mucous membranes are similarly affected by Bismuth, when in a condition of catarrh: thus it is used with success as a "snuff" for nasal catarrh; as an injection in gonorrhœa and leucorrhœa; and in irritability of the cervix uteri as a pessary. Bismuth is not known to be absorbed from unbroken surfaces.

Internally, the local action and uses of the Subnitrate of Bismuth constitute all, or nearly all, that is definitely known respecting it as a remedy. In the *stomach* it is insoluble, and exerts the same **sedative and astringent** action as on the skin, whether by affecting the nerves and local circulation, or by its mechanical properties, that is, by coating and protecting the mucous surface. The Liquor Bismuthi et Ammonii Citratis is decomposed by the acid gastric juice, depositing oxychloride as a white precipitate. Little or no good is to be expected from less than 20-gr. doses of the Subnitrate to an adult, and these may be increased with perfect safety. Bismuth is extensively used in this country in the treatment of pain and vomiting due to catarrh or organic disease of the stomach, such as the gastric catarrh that follows a surfeit of food or alcoholic excess, recurrent gastric ulcer, and cancer; also in some cases of so-called nervous or reflex vomiting, as in pregnancy and hysteria, where a true catarrh is often present. Bismuth may be given alone in such conditions, but is better combined, on the one hand, with alkalies, such as Bicarbonate of Sodium, if there be much actual catarrh; or, on the other hand, with Opium if pain be the chief symptom. A combination of the Subnitrate and Dover's Powder is almost a specific for the pain and vomiting of ulcer and malignant disease.

The astringent and sedative influence of Bismuth on the *intestines* constitutes it a valuable remedy for diarrhœa in delicate persons, such as children, phthisical subjects, and those who have been exhausted by other causes. In lienteric diarrhœa, probably referable to duodenal catarrh, it is sometimes invaluable. But in the intestines, as in the stomach, the addition of Opium, in however small quantity almost, greatly assists its action, and in persistent cases of diarrhœa is absolutely necessary. The same combination with Dover's Powder gives excellent results. Bismuth Subnitrate is partly converted into the sulphide in the bowels, which imparts a characteristic leaden-grey colour to the fæces.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Neither the insoluble nor the soluble (but weak) preparations of Bismuth enter the blood in any quantity. Still, the metal has been detected, both here and in the tissues. Bismuth very slowly finds its way through all the organs; but no specific effect can be attributed to the Subnitrate, even when given in doses of several drachms. Soluble salts of Bismuth, however, produce fatty degeneration in animals, exactly like Arsenic and Phosphorus. Bismuth has been found in the urine and milk, but no use is made of its remote influence, if any such exist.

GROUP III.

THE NON-METALLIC ELEMENTS.

The non-metallic elements of the Pharmacopœia fall for discussion into the following natural Subgroups: 1. Chlorum, Iodum, and Bromum; 2. Sulphur; and 3. Carbo. Phosphorus, which is pharmacologically allied with Arsenic, is described under Group II.

SUB-GROUP I.—CHLORUM, IODUM, BROMUM.

CHLORUM. CHLORINE. Cl. 35·5.

Although not contained in the Pharmacopœia as the pure gas under its own name, Chlorine is officially obtained from two different sources, namely: (1) Hydrochloric Acid, and (2) Chlorinated Lime.

1. **Liquor Chlori.**—Solution of Chlorine. Chlorine Gas dissolved in Water. It should be freshly prepared.

Source.—Made by heating Hydrochloric Acid and Water with Black Oxide of Manganese; passing the gas into water; and shaking till it is absorbed. $4HCl + MnO_2 = Cl_2 + MnCl_2 + 2H_2O$.

Characters. — A yellowish-green liquid, smelling strongly of Chlorine. *Incompatibles.*—Salts of lead and silver. *Impurities.*—Salts, not volatile; deficient chlorine, detected volumetrically by hyposulphite of sodium. *Dose*, 10 to 20 min. in water.

ACIDUM NITROHYDROCHLORICUM DILUTUM.—Contains free Chlorine. (*See* page 140.)

2. **Calx Chlorinata.**—Chlorinated Lime. $CaCl_2O_2$, $CaCl_2$ or $CaOCl_2$. A compound of Hypochlorite of Calcium and Chloride of Calcium, or directly of Lime and Chlorine.

Source.—Made by passing Chlorine Gas over Slaked Lime. $2CaH_2O_2 + 2Cl_2 = CaCl_2O_2,CaCl_2 + 2H_2O$.

Characters. —A dull white powder, with a feeble odour of Chlorine. Partially soluble in water. Bleaches and disinfects. Contains 33 per cent. available Chlorine.

Impurity.—Deficiency in Chlorine, detected volumetrically with hyposulphite of sodium.

Preparations.

a. LIQUOR CALCIS CHLORINATÆ.—1 in 10 of Water; mixed, agitated, and strained. Yields 3 per cent. available Chlorine.

b. VAPOR CHLORI. — Chlorinated Lime mixed with Cold Water, to evolve Chlorine.

From Calx Chlorinata is made:

Liquor Sodæ Chlorinatæ.—Solution of Chlorinated Soda. $NaCl,NaClO$.

Source.—Made by mixing solutions of Chlorinated Lime and Carbonate of Sodium; and filtering. $CaCl_2O_2,CaCl_2 + 2Na_2CO_3 = (NaCl,NaClO)_2 + 2CaCO_3$.

Characters.—A colourless liquid, with a feeble odour of Chlorine and an astringent taste. Alkaline. A mixed solution of Hypochlorite of Sodium and Chloride of Sodium, with Carbonate of Sodium. Sp. gr. 1·054. Contains 2·5 per cent. of available Chlorine; bleaches. *Dose*, 10 to 20 min.

Preparation.

CATAPLASMA SODÆ CHLORINATÆ.—2 of the Liquor, added to a mixture of 4 of Linseed Meal in 8 of Boiling Water.

Calx Chlorinata is also used in the preparation of Chloroform.

GENERAL CHEMICAL CHARACTERS OF CHLORUM PREPARATIONS.

These yield the characteristic odour of Chlorine when warmed with HCl and MnO_2.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, the action and uses of Chlorine depend upon the great affinity which it possesses for hydrogen, and its consequent power to decompose compounds in which hydrogen forms part of the molecule, such as ammonia, sulphuretted hydrogen, sulphide of ammonium, and water. The properties of the body on which it acts (chemical, vital, or both) are completely altered; whilst nascent oxygen is set free, and the Chlorine further combines with the remaining elements of the broken-down molecule. Thus it is a powerful **irritant** to the skin, causing redness, vesication, even sloughing, and coagulating the albuminates of the part. For the same reason, Chlorine is one of the most powerful of **disinfectants, deodorisers, and decolorisers,** its activity as a disinfectant greatly exceeding that of Carbolic Acid, and in some respects even Corrosive Sublimate. As a stimulant and disinfectant, Chlorine Water, or the Solutions of Chlorinated Lime or Chlorinated Soda, may be applied to foul ulcers, dissection and poisoned wounds, and diphtheritic surfaces; or used in contagious ophthalmia, ozæna, and other foul discharges from surfaces or cavities.

Of much more extensive application is the disinfectant action of Chlorinated Lime and its preparations apart from the body: to purify rooms, wash infected clothes, flush drains, and throw upon the stools of typhoid fever and cholera before they are disposed of.

Internally, Chlorine exerts a similar local action upon the parts with which it comes in contact; and is employed as a wash or gargle, to disinfect and stimulate foul ulcers of the mouth, tongue, and throat, especially in diphtheria.

In the stomach Chlorine in dilute solutions becomes converted into hydrochloric acid and chlorides, and loses all further effect upon the body as the uncombined element.

Inhaled as the Vapor, Chlorine causes local irritation of the respiratory passages, with distressing pain in the throat and chest, spasm, cough, lacrymation, sneezing, and headache. It cannot be recommended in this form.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

It is doubtful whether Chlorine enters the circulation or reaches the tissues uncombined; more probably it is entirely converted into chlorides. From the analogy of its powerfully disinfectant and bleaching properties apart from the body, it has been given in typhus, typhoid fever, small-pox, and other "putrescent" diseases, but there is little evidence in favour of continuing its use in these cases. In chronic dysentery, and liver disease of a malarial origin, Diluted Nitrohydrochloric Acid is a useful drug.

IODUM. IODINE. I. 127.

Under this head will be discussed both Iodine and the Iodides of Potassium and Sodium, the forms in which the element is generally administered internally. Reference will also be made to the other official Iodides.

Iodum.—Iodine. A non-metallic element.

Source.—Obtained from mineral iodides and iodates. Or from Kelp, the ashes of sea-weed, by lixiviation; concentration; treatment with H_2SO_4; and finally heating with MnO_2, when the Iodine volatilises. $2NaI$ (in lye) $+ 2H_2SO_4 + MnO_2 = I_2 + MnSO_4 + Na_2SO_4 + 2H_2O$.

Characters.—Laminar crystals of a dark colour and lustre, and peculiar odour, which yield a beautiful violet-coloured vapour when heated. *Solubility,* 1 in 7,000 of water, 1 in 12 of rectified spirit, 1 in 4 of ether, sparingly in glycerine, freely in a solution of iodide of potassium or chloride of sodium. *Incompatibles.*—Ammonia, metallic salts, mineral acids, vegetable alkaloids. *Impurities.* — Iodide of cyanogen; subliming as colourless prisms. Iron; not volatile. Water; as moisture.

Preparations.

1. **Linimentum Iodi.**—Iodine, 5; Iodide of Potassium, 2; Glycerine, 1; Spirit, 40. 1 in 9½.

2. **Liquor Iodi.**—Iodine, 10; Iodide of Potassium, 15; Water, 200. 1 in 20.

3. **Tinctura Iodi.**—Iodine, ½; Iodide of Potassium, ½, Spirit, 20. 1 in 40. *Dose,* 5 to 20 min.

From Tinctura Iodi is prepared:

VAPOR IODI. — Tincture of Iodine, 1 fl.dr.; Water, 1 fl.oz. Mix, and apply a gentle heat.

4. **Unguentum Iodi.**—Iodine, 7; Iodide of Potassium, 7; Glycerine, 12; Lard, 191.

From Iodum is made:

5. **Potassii Iodidum.**—Iodide of Potassium. KI.

Source.—Obtained by (1) dissolving Iodine in Liquor Potassæ, and evaporating to dryness: $6KHO + 3I_2 = 5KI + KIO_3 + 3H_2O$. (2) Mixing the residue with Wood Charcoal and fusing, thus converting the iodate, which was formed with the iodide, into iodide: $2KIO_3 + 6C = 2KI + 6CO$. (3) Dissolving and purifying.

Characters.—Colourless, opaque, cubic crystals, with some odour of iodine, a saline taste, and feebly alkaline reaction. *Solubility,* 4 in 3 of water; less freely in spirit.

Strikes blue with preparations containing starch on addition of chlorine. *Impurities.*—Iodate, detected by blue colour with tartaric acid and starch; free iodine, by starch; and the impurities of Liquor Potassæ. *Dose,* 2 to 20 gr.

Preparations.

a. LINIMENTUM POTASSII IODIDI CUM SAPONE. —Iodide of Potassium, 12; Curd Soap, 16; Glycerine, 8; Oil of Lemon, 1; Water, 80.

b. UNGUENTUM POTASSII IODIDI. — Iodide of Potassium, 16; Carbonate of Potassium, 1; Water, 14; Benzoated Lard, 110.

c. Also all the preparations of Iodum.

6. **Sodii Iodidum.**—Iodide of Sodium. NaI.

Source.—Made by the same process as Iodide of Potassium, Solution of Soda being used in place of Solution of Potash.

Characters.—A dry, white, crystalline, deliquescent powder, with a saline and bitter taste; readily soluble in water and spirit. *Dose,* 3 to 10 gr.

Iodine is also used in the production of Iodoform, and the Iodides of Arsenium, Ferrum, Hydrargyrum, Plumbum, and Sulphur, or preparations containing them.

GENERAL CHEMICAL CHARACTERS OF IODUM AND ITS SALTS.

Iodine is entirely volatilised by heat with the evolution of violet vapours. Aqueous solutions strike a deep blue with starch. Solutions of Iodides give the same reaction when decomposed by solution of chlorine; also a yellow precipitate with $AgNO_3$, insoluble in HNO_3, soluble in NH_4HO. Solutions of Iodine may be decolorised by Hyposulphite of Sodium.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, Iodine is a powerful **irritant and vesicant**, decomposing organic molecules, and entering into loose chemical combination with the albuminous constituents of the parts. At the same time it stains the epidermis of a deep brown; causes considerable pain; and is absorbed into the blood, partly by the skin and partly by the air of respiration in the form of vapour. It is also a very powerful **antiseptic and disinfectant.**

The Tincture, Liniment, and Ointment of Iodine are extensively used as stimulants and disinfectants to foul callous ulcers, much like Nitrate of Silver; as vegetable parasiticides in ringworm; and as counter-irritants in subacute or chronic inflammation of joints, periosteum, lymphatic glands, the pleura, and the lungs, for which purpose the Ointments of the Iodides of Lead and Mercury are also applied. In these instances the chief effect is doubtless stimulation; but a certain amount of the Iodine is absorbed, and acts specifically, as will be presently described. Iodine in solution is injected into cysts, goîtres, hydrocele, etc., with much success.

Iodide of Potassium applied to the unbroken skin is neither irritant nor capable of being absorbed, unless decomposed by the sweat. It is readily taken up from the exposed mucous membranes. How much specific value can be attached to the Iodide Liniment is doubtful.

Internally, the local action of free Iodine is also irritant, and the Tincture is successfully applied to the gums in periosteal toothache. Inhaled into the respiratory passages, it gives rise to cough, sneezing, severe pain over the frontal sinuses, distressing pains in the chest, and dyspnœa. Compounds of Iodine with Creasote and various soothing volatile substances, such as Chloroform and Ether, have lately come into repute as continuous inhalations in the so-called "antiseptic"-treatment of phthisis, bronchitis, and other forms of chronic lung disease.

In the stomach and bowels, although it is gradually converted into the Iodide or Iodate of sodium, the irritant effects of free Iodine are continued, with abdominal pain, sickness, and diarrhœa as the result. The Iodide of Potassium or Sodium has rarely this effect, and it is only in the form of a salt that Iodine is now administered internally. Iodide of Potassium is also decomposed in the stomach, the sodium salt and albuminate being formed from it.

2. ACTION ON THE BLOOD.

Iodine is freely absorbed into the blood from mucous surfaces, and the Sodium Iodide quickly enters from the alimentary canal. In the blood the element is at first combined with sodium; but this salt appears to be decomposed, the Iodine for a time set free, some of the red corpuscles broken down (if the amount of Iodine be large), and bloody effusions and bloody urine make their appearance. Such results are to be carefully avoided in practice; and as far as we know, less degrees of the same cannot be usefully applied to therapeutical purposes, unless the tendency to coagulation be somewhat increased by it.

3. SPECIFIC ACTION AND USES.

The Iodide of sodium and albuminous compounds pass from the blood into the tissues with remarkable rapidity, and may be found in all of them, especially the excreting organs and lymphatic glands, whilst they appear very scantily in the nervous centres. According to Binz, the Iodine is liberated in the tissues. Almost as quickly it again leaves the tissues; and in thus passing rapidly through the protoplasm of the body, and sharing in its metabolism by combining (probably very loosely) with the albuminous molecules, Iodine no doubt **accelerates tissue change.** As no increase of urea accompanies this effect, nor bodily wasting, the Iodine must either spare the liver (which is the chief source of urea), or accelerate the metabolism of the plasma, rather than of the tissue elements themselves. (See *Metabolism*, Part III.) However this may be, the following are the principal directions in which Iodine affects nutrition, and the applications of the same:

(1) The *lymphatic glands* are reduced in size by Iodine, which is extensively used for **scrofulous** and other chronic enlargements of the glands, whether applied locally as Iodine, or administered internally as the Iodides.

(2) Certain *poisons* which have intimately associated themselves with the albuminous structures, are disengaged from these combinations by Iodine. Lead and Mercury may be swept out of the tissues by Iodide of Potassium, administered for plumbism and hydrargyrism respectively.

(3) The principal application, however, of iodine is in the treatment of **syphilis.** Either the poison of this disease is thus eliminated from the system, or Iodine hastens the life and disappearance of the small-celled growth by which syphilis is characterised. It is specially valuable in the tertiary forms of syphilis, when Mercury cannot be longer given with advantage; and nodes and other superficial enlargements, gummata in the viscera, and certain forms of skin disease, may be very successfully treated by the Potassium salt. The same precautions must be observed with respect to the general health, and especially the preservation of digestion, in a course of Iodine, as are laid down under the head of Mercury.

(4) In subacute and **chronic inflammations** of various kinds, such as exudations or effusions in connection with the joints and serous cavities, and some forms of pulmonary consolidation, Iodide of Potassium may promote absorption by stimulating the local nutrition. The local application of Iodine "paint" is combined in such cases.

(5) *Scrofula* is benefited by Iodine, especially when it

affects the lymphatic glands, enlargements of which are treated by the Liniment, or the Ointment of the Iodide of Lead, by interstitial injections (rarely); internally by Iodide of Iron, or Iodine mineral waters, such as the Water of Woodhall. On the contrary, phthisis is rarely benefited by Iodides, unless there be a syphilitic taint present.

(6) In chronic *rheumatism* where debility is not a prominent symptom, in gonorrhœal rheumatism, and in the arthritis of syphilis, the Iodide may be beneficial. In chronic arthritic gout it is probably useless, or even prejudicial.

Binz holds that free Iodine and its readily decomposable compounds are narcotic, paralysing the cerebral centres by direct action on the nervous structures, and finally proving fatal through the respiratory centre. The heart, vessels, and body temperature are unaffected by Iodine; and the depressing effect on these of large doses of Iodide of Potassium is believed to be caused by the Potassium. The remarkably useful effect of Iodide of Potassium in relieving or curing **aneurysm** is due to the reduction of the blood pressure by the alkali, the coagulating effect of Iodine on the blood, and the specific effect of Iodine on the chronic inflammatory changes (often syphilitic) in the wall of the artery which have led to the dilatation.

4. REMOTE LOCAL ACTION AND USES.

Iodine is rapidly excreted, appearing in the urine, the mucous secretions generally (specially in those of the air passages), the perspiration, saliva, bile, and milk. Part of the sodium salt which reaches the excreting organs is thrown out unchanged, part is decomposed, and Iodine again set free to exert its local action remotely.

The diuretic effect of Iodide of Potassium is not marked unless large doses be given, and probably depends upon the alkali, not on the Iodine. The latter may, however, have an alterative action upon the kidney, and the Iodide may therefore be used in some forms of chronic Bright's disease, combined with other remedies.

The excretion of Iodine by the mucous membrane of the respiratory tract is of most interest to the therapeutist. In certain subjects, and probably when Iodide of Potassium contains free Iodine as an impurity, its exhibition produces a series of distressing symptoms known as "iodism," consisting of coryza, the watery discharge from the nose being sometimes profuse; sneezing; intense pain of a bursting character over the frontal sinuses, commonly called "headache;" swelling and redness of the gums, hard and soft palate, and fauces, foulness of the tongue, and increase of the mucus of the mouth;

cough and frothy expectoration, and a sense of heat and rawness in the trachea and chest. The phenomena of irritation of the respiratory mucosa by the out-going Iodine are therefore identical with those produced by the immediate action of Iodine by inhalation, but in a minor degree. In bronchial catarrh, when the secretion is deficient, the mucous membrane of the bronchi swollen and dry, and cough useless and painful, Iodide of Potassium is a valuable **expectorant**, quickly inducing a flow of thin mucus, by establishing secretion, or by liquefying tenacious mucus which may be plugging or irritating the bronchi. It is, further, an indirect **antispasmodic**, given with great benefit in asthma and emphysema. The Iodide of Ethyl (non-official) inhaled as vapour may rapidly relieve the spasm of asthma. Iodide of Potassium is sometimes given in other respiratory diseases, *e.g.* in pneumonia, if the consolidation threaten to persist.

In escaping by the skin the liberated Iodine produces in certain individuals peculiar **eruptions** : papular, acneiform, vesicular, or plastic, rarely purpuric. The value of the drug in tertiary syphilitic skin diseases and in some forms of lupus no doubt depends partly on this influence.

5. ACTION AND USES OF THE SEVERAL PREPARATIONS CONTAINING IODINE.

1. *Ferri Iodidum.*—Pilula Ferri Iodidi and Syrupus Ferri Iodidi combine the action of the two important elements, and are especially indicated and extensively employed when Iodine has to be administered for a length of time to anæmic subjects. This is the form in which Iodine is usually given in scrofula, the syrup being a favourite remedy for strumous children.

2. *Hydrargyri Iodidum Rubrum* possesses chiefly the action of the Per-salts of Mercury, and is used accordingly. See *Hydrargyrum.*

3. *Sulphuris Iodidum* is now used externally only, and is believed to produce the combined effects of the two alteratives.

BROMUM. Bromine. Br. 80.

Along with Bromine will be discussed Diluted Hydrobromic Acid and the three official Bromides of Ammonium, Potassium, and Sodium.

Bromum. Bromine. A liquid non-metallic element. *Source.*—Obtained from sea-water, and from some saline springs, by heating its natural Magnesium compound with Oxide of Manganese and Sulphuric Acid. $MgBr_2 + MnO_2 + H_2SO_4 = Br_2 + MnSO_4 + MgO + H_2O$.

Characters.—A dark brownish-red, very volatile liquid, with a strong disagreeable odour. *Solubility*, 1 in 30 of water. *Impurity.*—Iodine; detected by starch test.

From Bromum are made:

1. **Acidum Hydrobromicum Dilutum.**— Diluted Hydrobromic Acid. A liquid composed of 10 per cent. of gaseous or absolute Hydrobromic Acid and 90 per cent. of water.

Source.—Distilled from a Solution of Bromine in water, through which Sulphuretted Hydrogen has been previously passed, the first and last portions of sulphuretted compounds being rejected. $10Br_2 + 4H_2S + 8H_2O = 20HBr + S_2 + 2H_2SO_4$.

Characters.—A colourless liquid, odourless, with a strong acid taste, and acid reaction. It yields Bromine when heated with MnO_2 and H_2SO_4.

2. **Ammonii Bromidum.**—Bromide of Ammonium. NH_4Br.

Source.—Made by neutralising Hydrobromic Acid with Liquor Ammoniæ, evaporating, and crystallising. $HBr + NH_4HO = NH_4Br + H_2O$.

Characters. — Colourless crystals, which become slightly yellow by exposure to the air, and have a pungent saline taste. *Solubility*, 1 in 1½ of water; less soluble in spirit. Sublimes by heat. *Impurities.*—Iodides; free bromine. *Dose*, 2 to 20 gr.

3. **Potassii Bromidum.**—Bromide of Potassium. KBr.

Source.—Obtained from Liquor Potassæ, Bromine, and Charcoal, by a similar process to that by which the Iodide of Potassium is made. (*See* page 123.)

Characters. — Colourless cubic crystals, without odour, of a pungent saline taste. *Solubility*, readily in water. Does not strike blue with preparations containing starch, unless it contain iodide as impurity. *Dose*, 5 to 30 gr.

4. **Sodii Bromidum.**—Bromide of Sodium. NaBr.

Source.—Made by (1) dissolving Bromine in Solution of Soda, and evaporating; (2) mixing the residue with charcoal, and fusing; (3) dissolving and purifying.

Characters.—A granular white powder of small monoclinic crystals, somewhat deliquescent, inodorous, with saline taste. *Solubility*, 1 in less than 2 of water; less so in spirit. *Dose*, 10 to 30 gr.

GENERAL CHEMICAL CHARACTERS OF BROMUM AND ITS SALTS.

Bromine gives a yellow colour with starch paste; a brown solution in CS_2. Bromides give a yellowish-white precipitate with $AgNO_3$; sparingly soluble in NH_4HO.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally Bromine is a powerful **irritant and escharotic.** Its local use is confined to the treatment of cancer of the cervix uteri (1 in 5 parts of rectified spirit). The Bromides have no such irritant action unless in highly concentrated solution. They are not absorbed from the unbroken skin.

Internally, the local action of Bromine resembles that of Chlorine, the vapour being intensely irritant, and, indeed, irrespirable. It is never used in this way.

The Bromides taken continuously for a time in full doses, or applied in strong solution to the throat, are said to reduce the sensibility of the fauces, so that the reflex movements of the parts, such as swallowing, vomiting, and cough, are not easily excited. They have therefore been employed previous to examinations or operations in connection with the larynx, but Cocaine has now quite displaced them for this purpose. The Bromides have but little effect of an irritant kind on the stomach or bowels, so that large doses (20 grains thrice a-day for years) may be readily borne. The greatest care must always be taken, however, to preserve digestion and regularity of the bowels, in cases where Bromides are continuously prescribed.

2. ACTION IN THE BLOOD.

Bromide of Potassium, the salt most commonly employed, enters the blood unchanged, where it is probably converted into the sodium salt by double decomposition with the chloride of sodium. For a moment it may be set free in the blood, but no special action or therapeutic application can be referred to this circumstance.

3. SPECIFIC ACTION AND USES.

The Bromides appear to pass through the organs as Bromide of Sodium, and have a very definite specific action upon them, which, generally speaking, is one of depression.

The *nervous system* is specially affected. **Loss of reflex excitability** in connection with all the sentient surfaces of the body follows the administration of full medicinal doses. This result is due partly to depression of the peripheral (sensory) nervous filaments, but chiefly to reduced activity of the nervous centres in the brain and cord. At the same time the motor nerves are also soothed, and the *muscular* power (which we may conveniently consider along with the nervous), is much weakened. The phenomena of this general nervo-muscular depression are as follows, beginning with the highest centres :

The Bromides lessen cerebral activity, readiness to react to emotional stimuli, and sensibility and irritability of mind generally, thus inducing a condition of brain favourable to the advent of sleep. They are thus indirect **hypnotics**, not acting like Opium and Chloral, but so reducing the patient's sensibility of his surroundings, bodily condition, or circumstances, as to prevent distraction, and allow natural sleep to supervene. It is uncertain whether the Bromides act upon the nerve cells directly, or upon the cerebral blood-vessels. The soothing and hypnotic effects of the Bromides are very extensively employed in restlessness and sleeplessness from mental strain, whether emotional or intellectual, in the acute specific fevers when similar symptoms are urgent, in acute alcoholism, and in mania. In the three last conditions a certain amount of Chloral or Opium may be advantageously combined with the Bromides. Bromide of Lithium, not official, but a very active hypnotic, will sometimes remove the insomnia of gout. The most important application of the soothing action of the Bromides is in **epilepsy,** which is now almost exclusively treated with these salts, unless they be contra-indicated. Hysteria, infantile convulsions, whooping cough, general "nervousness," hypochondriasis, gastric and intestinal disorders of reflex origin, sea-sickness, and the low despondent condition so common in women with uterine irregularities, are also relieved by Bromides, although not with the success obtained in epilepsy.

The great vital centres of the *medulla* are depressed by Bromides. Respiration becomes weakened and slower, whence possibly part of the value of the drug in whooping cough. **The heart is also slowed and weakened** in its action ; chiefly, however, by depression of its nervo-muscular substance, not of the cardiac centre. Bromides are of much service, therefore, in nervous disorders of the heart, especially in hysterical, dyspeptic, and alcoholic subjects. The direct effect of these drugs on the vessels is unsettled ; as a whole, the tension is reduced.

The spinal centres and spinal nerves, and the muscles,

are all depressed by the Bromides, the former so much so that the convulsions of Strychnine poisoning cannot be induced, and the two drugs are so far physiological antagonists. In such a case, and in tetanus, the Bromides may be given, but they are neither rapid nor powerful enough to be trusted to alone.

The temperature is lowered by Bromides, but not to an extent of much practical value.

The ovarian and uterine functions are quieted, and menorrhagia relieved, by these drugs.

4. REMOTE LOCAL ACTION AND USES.

The Bromides appear in the secretions within a few minutes after their administration, being eliminated by the kidneys chiefly, by the salivary glands, mammæ, skin, and all mucous surfaces. In passing through these excreting organs, the Bromides break up and set free Bromine, which exerts a second stimulant effect on the parts. The urinary constituents are irregularly disturbed; but not in a manner that can be turned to therapeutical account. Infants at the breast may be affected by Bromine in the milk. The **skin** is markedly affected, a characteristic acne-like **eruption** appearing, or other forms of skin disease, which are familiar in epileptics consuming large quantities of the drug. Cough is occasionally set up, and conjunctivitis may also occur. The interest to the therapeutist of all these remote effects of the Bromides lies in their prevention, if possible, in cases where the drugs have to be steadily taken for an indefinite time, an end which may sometimes be secured by combining them with arsenic.

Hydrobromic Acid possesses many of the properties of the Bromides, but is less useful than Bromide of Potassium. It is said to prevent the cerebral symptoms produced by Quinine, which it readily dissolves, and the after-effects of Morphine, if given with these drugs.

SUB-GROUP II.

SULPHUR. SULPHUR. S. 32.

Under this head will be discussed not only Sulphur, but the official Sulphides, the form in which the element is chiefly active physiologically. Sulphur is found native as virgin sulphur, and as sulphides of metals. It is the source of all the preparations, with the exception of Calx Sulphurata, which is made by reduction of a sulphate.

1. Sulphur Sublimatum.—Sublimed Sulphur. "Flowers of Sulphur."

Source.—Prepared from crude or rough sulphur by sublimation in a large chamber.

Characters.—A fine greenish-yellow gritty powder, without taste or odour until heated; neutral. Insoluble in water; soluble in carbon disulphide, fixed oils, and turpentine, with heat. *Impurities.*—Sulphurous and Sulphuric Acids; detected by test-paper. Sulphide of Arsenic, detected by yielding a residue on agitation with ammonia, and evaporating. Earthy matters. *Dose*, 20 to 60 gr.

Preparations.

a. CONFECTIO SULPHURIS.—Sublimed Sulphur, 4; Acid Tartrate of Potassium, 1; Tragacanth, $\frac{1}{24}$; Syrup of Orange Peel, 4. *Dose*, 60 to 120 gr.

b. UNGUENTUM SULPHURIS.—Sublimed Sulphur, 1; Benzoated Lard, 4.

From Sulphur Sublimatum are made:

c. **Sulphur Præcipitatum.**—Precipitated Sulphur. "Milk of Sulphur."

Source.—Made by (1) boiling Sublimed Sulphur with Slaked Lime in water; (2) precipitating the filtrate with diluted Hydrochloric Acid, washing and drying. (1) $12S + 3CaH_2O_2 = 2CaS_5 + CaS_2O_3 + 3H_2O$. (2) $2CaS_5 + CaS_2O_3 + 6HCl = 3CaCl_2 + 6S_2 + 3H_2O$.

Characters.—A greyish-yellow soft powder. *Impurities.*—Sulphate of Lime; H_2SO_4 being used instead of HCl; detected by grittiness, and microscopically as crystals. Sulphuretted hydrogen; detected by odour. *Dose*, 20 to 60 gr.

d. **Potassa Sulphurata.**—Sulphurated Potash. "Liver of Sulphur."

Source.—Made by fusing Sublimed Sulphur with Carbonate of Potassium, and breaking into pieces.

Characters.—Solid greenish fragments, liver-brown when recently broken; alkaline; acrid to the taste; readily forming with water a yellow solution smelling of H_2S, which is evolved on addition of HCl. A mixture of Potassium Salts, of which the chief is Sulphide.

Preparation.

UNGUENTUM POTASSÆ SULPHURATÆ.—1 in 15½ of Hard and Soft Paraffin.

e. **Sulphuris Iodidum.**—Iodide of Sulphur. SI.

Source.—Made by fusing Sublimed Sulphur with Iodine; cooling till solid, and breaking into pieces.

Characters.—Greyish-black crystalline pieces, smelling strongly of Iodine. *Solubility*, 1 in 60 of glycerine; insoluble in water.

Preparation.

UNGUENTUM SULPHURIS IODIDI.—1 in 15½ of Hard and Soft Paraffin.

Sublimed Sulphur is also contained in Pulvis Glycyrrhizæ Compositus (1 in 12); *and is used in preparing* Emplastrum Hydrargyri, Emplastrum Ammoniaci cum Hydrargyro, and Antimonium Sulphuratum.

2. Calx Sulphurata.—Sulphurated Lime. A mixture containing not less than 50 per cent. of CaS.

Source.—Made by heating a mixture of Sulphate of Calcium and Wood Charcoal.

Characters.—A nearly white powder, smelling of sulphuretted hydrogen. *Dose*, $\frac{1}{10}$ to 1 gr.

GENERAL CHEMICAL CHARACTERS OF SULPHUR.

Sulphur burns with a blue flame. Most Sulphides evolve H_2S with HCl.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, Sulphur has probably no local action of itself, but is partially converted, by contact with the acid products of the skin, into sulphuretted hydrogen and sulphides, which are energetic substances. Whether, therefore, rubbed on as ointment, worn in flannel, distributed over the surface by fumigation, or given as a natural or artificial bath of "sulphur waters," it is not Sulphur, but its hydrogen compound, which possesses local therapeutical properties.

Sulphuretted Hydrogen, when brought in contact with the skin in any of the forms just mentioned, is a **vascular stimulant and nervous sedative.** It is probably on this account that Sulphur has long been regarded as useful in relieving the pains of chronic rheumatism, and as an **alterative** in certain kinds of skin disease, such as acne, in which the Ointment of the Potassa Sulphurata is especially valuable. The solution of the gas is also absorbed by the skin, and is extolled (in the form of baths) in lead and mercury poisoning, syphilis, and chronic enlargements of joints. The *rationale* of these effects will be presently discussed.

Sulphur and Sulphurated Potash and Lime destroy the *Acarus scabici*, and are used in the treatment of itch. Iodide of Sulphur is a local stimulant and alterative. See *Iodum*.

Internally, Sulphur has been locally applied to the throat in diphtheria, but with disappointing results.

In the stomach it remains unaltered, and passes as such into the intestines, where a small portion becomes converted into Sulphides, and acts as a purgative, possibly by increasing peristalsis, more probably by stimulating the glandular structures. Medicinal doses of Milk of Sulphur, the Confectio, or the Pulvis Glycyrrhizæ Compositus, are simple **laxatives**, producing an easy soft stool, with little or no pain. Sulphur Waters, drunk freely at Harrogate and Strathpeffer in this country, at Aix-la-Chapelle, Challes, Aix-les-Bains, and the Pyrenees, on the continent of Europe, and at the Blue Lick, Alpena, Sharon, and other springs in the United States, have a similar but more powerful effect, producing considerable disturbance of the bowels, and depressing the portal circulation. Sulphur and Sulphur Waters are extensively used as purgatives in congestion of the rectum and liver, hæmorrhoids, and other diseases of the great bowel; and the waters and baths combined are powerful evacuants and alteratives in plethora, hepatic engorgement, gravel, and disorders originating in them.

Sulphur in some measure escapes unabsorbed in the fæces, partly unchanged, partly as sulphides of hydrogen and the alkalies which it has encountered in the bowel, the activity of purgation varying indirectly with the extent of absorption.

2. ACTION ON THE BLOOD.

The amount of Sulphur which enters the blood in the form of sulphides of hydrogen and the alkalies, under the use of Sulphur or Sulphur Waters, produces no obvious effect upon it. When *inhaled* into the circulation, sulphuretted hydrogen is a powerful blood poison, acting both on the red corpuscles and the plasma. It reduces the oxyhæmoglobin of the former, and converts the carbonates and phosphates of the latter into sulphides, sulphites, and sulphates; but this subject is not of therapeutical interest.

3. SPECIFIC ACTION AND USES.

The hydrogen and alkaline sulphides pass into the tissues from the blood, and act chiefly upon the central nervous system. When in large quantity, they induce rapid failure of the nerve centres, especially those of respiration and circulation, the subject dying rather of asphyxia than from the poisonous influence on the blood just described. It is possible that the headache and nervous depression, which attend the use of Sulphur Waters in some persons, are minor degrees of these effects. It is possible also that Sulphur and its compounds, possessing these powerful influences on the blood and tissues (which appear to be of the nature of arrest of oxydation), may modify nutrition to some extent even in medicinal doses, and thus possess **alterative** properties. In chronic rheumatism, syphilis, gout, and skin diseases, they have been much prescribed from time immemorial, especially at watering places. Sulphurated Lime has lately been found useful in scrofulous disease of bones, and in influencing suppuration.

4. REMOTE LOCAL ACTION AND USES.

It is under this head that we find the principal suggestions for the therapeutical employment of Sulphur. The sulphides which we have traced through the blood and tissues are variously excreted. By the kidneys they pass out as sulphates, and it is said that one half of a dose of Sulphur Præcipitatum can be thus recovered from the urine, but only one-fifth of Sulphur Sublimatum. If in excess, part is also excreted as sulphides. No special use is made of these facts. By the skin they escape as sulphides, giving the characteristic foul odour to the perspiration, and somewhat increasing its amount. Sulphur is used as a **mild cutaneous stimulant and diaphoretic**, and has always been regarded as a valuable internal remedy for many skin diseases, such as acne, chronic eczema, psoriasis, and syphilitic eruptions. Drinking the waters and taking the baths at Sulphur springs probably act in this remote local way. Sulphide of Calcium is specially useful in boils. The sulphides are also excreted by the bronchi and lungs, giving their odour to the breath; and Sulphur was once much used as an **expectorant**, especially in chronic bronchitis with abundant expectoration and gouty or rheumatic associations.

The valuable effect of Sulphur Waters, taken internally and used as baths, in cases of chronic rheumatism, gout, skin disease, plethora, etc., is principally, if not entirely, to be accounted for by the immediate and remote local action of the

Sulphides on the bowels and portal system, and on the kidneys, skin, and bronchi respectively. It is an important fact that Sulphur is a **purgative alterative.**

The action and uses of burned Sulphur as a disinfectant depend on the Sulphurous Acid which is formed, and are described at page 147.

SUB-GROUP 3.

CARBO. CARBON. C. 12.

Two kinds of Carbon are official, namely, Charcoal from bones and Charcoal from wood.

1. **Carbo Animalis.**—Animal Charcoal. Bone Black.

Source.—Made by exposing bones to a red heat without the access of air, and powdering the residue.

Characters.—A greyish-black coarse powder; insoluble in water. Contains only 10 per cent. of pure carbon, the rest consisting chiefly of phosphate and carbonate of calcium.

From Carbo Animalis is made:

> **Carbo Animalis Purificatus.**—Animal Charcoal from which the salts have been wholly removed.
>
> *Source.*—Made by digesting Animal Charcoal in diluted Hydrochloric Acid; filtering; washing the undissolved part; and heating to redness in a closed crucible.
>
> *Characters.*—A black powder, inodorous, and nearly tasteless. *Dose,* 20 to 60 gr. As antidote, $\frac{1}{2}$ oz. repeatedly.

2. **Carbo Ligni.**—Wood Charcoal.

Source.—Wood charred by exposure to a red heat without access of air.

Characters.—Black, brittle, porous masses, without taste or smell, and retaining the form and texture of wood; when burned, leaves not more than 2 per cent. of vegetable ash. *Dose,* 20 to 60 gr.

Preparation.

> CATAPLASMA CARBONIS.—Wood Charcoal, 1; Linseed Meal, 3; Bread Crumb, 4; and boiling Water, 20.

Purified Animal Charcoal is used in the preparation of such drugs as Morphine and Atropine, as a decolorising agent.

ACTION AND USES.

Externally.—Charcoal absorbs and condenses many gaseous bodies and vapours, as oxygen, carbonic acid, etc. ; and attracts and oxydises the colouring, odoriferous, and sapid principles of many liquid substances, for example, litmus, bitters, wines, and decomposing fluids. It is used as a **deodorant and disinfectant** to absorb tho foul emanations from cancerous and other discharges, ulcers, and wounds, being either hung around the bed in bags, or directly applied in dust, or as the poultice (a bad form).

Internally.—Charcoal is locally used as a dentifrice. When taken into the stomach in sufficient bulk, either pure, or in the form of biscuits, it absorbs any gas and acrid products of indigestion which may bo distending and distressing the organ, and is useful as a **carminative** in some forms of flatulent dyspepsia. Animal Charcoal has been recommended by Dr. Garrod as an **antidote** in poisoning by opium, nux-vomica, aconite, and other organic poisons, the alkaloids of which it attracts from their solutions in the stomach, and renders inert. In the intestines it may possibly reduce flatulence, disinfect the fæces, and thus diminish the reflex peristaltic movements and relieve diarrhœa. It is doubtful, however, whether the absorptive action of Charcoal can be retained in the bowel, or even in the stomach, after it has been thoroughly brought in contact with water.

Charcoal is entirely evacuated by the bowel and is not absorbed, so that it exerts no specific action on the body.

GROUP IV.

ACIDS.

The official Acids may be classified as follows :

1. **Inorganic Acids.**—Sulphuric, Nitric, Hydrochloric, Nitro-Hydrochloric, Phosphoric, Boric, Chromic, Hydrobromic, and Sulphurous. Of these, Hydrobromic Acid is described under *Bromum*, page 129. Arsenious Acid is an anhydride, not a true acid.

2. **Organic Acids.**—Acetic, Citric, Tartaric, Lactic, Hydrocyanic Diluted, Carbolic, Benzoic, Gallic and Tannic, Meconic, Oleic, and Salicylic. Of the

Organic Acids, the first four only will be discussed here; the action and uses of the other substances being but little connected with their properties as acids. Oxalic Acid is contained in the Appendix as a test.

ACIDUM SULPHURICUM, NITRICUM, HYDROCHLORICUM, NITROHYDROCHLORICUM DILUTUM, PHOSPHORICUM CONCENTRATUM, ACETICUM, CITRICUM, AND TARTARICUM.

These substances are conveniently considered together. They all possess distinctly acid properties; that is, they neutralise alkalies, and turn blue litmus red.

Acidum Sulphuricum.—Sulphuric Acid. H_2SO_4, Real Sulphuric Acid, 98 per cent. by weight, in Water.

Source.—Obtained by the combustion of Sulphur; and the oxydation by nitrous fumes, and hydration by aqueous vapour, of the resulting sulphurous acid gas.

Characters.—A colourless, oily-looking, intensely acid liquid. Sp. gr. 1·843. Soluble Sulphates give a heavy white insoluble precipitate with $BaCl_2$. *Impurities.*—Nitric acid, lead, arsenic, and carbonaceous matter.

Preparations.

1. **Acidum Sulphuricum Dilutum.**—1, to about 11 of Distilled Water. Sp. gr. 1·094. *Dose*, 5 to 30 min.

From Acidum Sulphuricum Dilutum is prepared:

Infusum Rosæ Acidum.—1 to 80. *See* page 267.

2. **Acidum Sulphuricum Aromaticum.**—Prepared by mixing Sulphuric Acid, 1½; Spirit, 18; Spirit of Cinnamon, 1; Strong Tincture of Ginger, 1. Sp. gr. 0·911. *Dose*, 5 to 30 min.

From Acidum Sulphuricum Aromaticum is prepared:

Infusum Cinchonæ Acidum.— 1 in 80. *See* page 291.

3. Many Sulphates and other preparations.

Acidum Nitricum. — Nitric Acid. HNO_3, Real Nitric Acid, 70 per cent by weight, in Water.

Source.—Prepared from Nitre by distillation with Sulphuric Acid and Water.

Characters.—A colourless, intensely acid, fuming liquid. Sp. gr. 1·42. If a solution of a Nitrate be added to H_2SO_4 at the bottom of a test-tube, and solution of $FeSO_4$ carefully added after cooling, a black-brown ring will be formed at the line of junction of the first two fluids. *Impurities.*—Sulphuric and hydrochloric acids; mineral matter; excess of water; lower oxides of nitrogen, known by ruddy fumes.

Preparations.

1. **Acidum Nitricum Dilutum.**—1, to fully 4 of Distilled Water. *Dose*, 10 to 30 min.

2. **Acidum Nitrohydrochloricum Dilutum.**—3, with Hydrochloric Acid, 4; and Distilled Water, 25. To be made fourteen days before using. It contains free chlorine, hydrochloric, nitric, and nitrous acids, and other compounds dissolved in water. *Dose*, 5 to 20 min.

3. Many Nitrates and other preparations.

Acidum Hydrochloricum.—Hydrochloric Acid. HCl, about 32 per cent. by weight, dissolved in Water.

Source.—Obtained by the action of Sulphuric Acid upon Chloride of Sodium, and solution of the fumes in Water.

Characters.—A nearly colourless, very acid liquid, with pungent odour. Sp. gr. 1·16. Chlorides give a white curdy precipitate with $AgNO_3$, soluble in NH_4HO; insoluble in HNO_3. *Impurities.*—Sulphuric and sulphurous acids, arsenic; excess of water.

Preparations.

1. **Acidum Hydrochloricum Dilutum.**—1, to fully $2\frac{1}{4}$ of Distilled Water. *Dose*, 10 to 30 min.

2. **Acidum Nitrohydrochloricum Dilutum.**—*See Acidum Nitricum.*

3. Many Chlorides and other preparations.

Acidum Phosphoricum Concentratum.—Phosphoric Acid. H_3PO_4, with 33·7 per cent. of Water.

Source.—Made by boiling Phosphorus with Nitric Acid and Water; evaporating till coloured vapours cease; and diluting with Water. $3P_4 + 20HNO_3 + 8H_2O = 12H_3PO_4 + 20NO$.

Characters.—A colourless syrupy liquid, with a sour taste, and strongly acid reaction. Sp. gr. 1·5. Phosphates give a yellow precipitate with $AgNO_3$, soluble in NH_4HO and in

HNO_3. *Impurities.*—Arsenic, lead, sulphuric, nitric, hydrochloric, and pyro- and meta-phosphoric acids. *Incompatibles.*—Calcium salts; carbonate of sodium. *Dose*, 2 to 5 min.

Preparation.

Acidum Phosphoricum Dilutum.—Diluted Phosphoric Acid. 1, to $5\frac{2}{3}$ of Distilled Water. *Dose*, 10 to 30 min.

Concentrated Phosphoric Acid is used in preparing Syrupus Ferri Phosphatis; *Diluted Phosphoric Acid*, Ammonii Phosphas.

Acidum Aceticum.—Acetic Acid. $HC_2H_3O_2$, Real Acetic Acid, 33 per cent. by weight, in Water.

Source.—Prepared from Wood by destructive distillation and purification.

Characters.—A colourless liquid, with a pungent odour and strong acid reaction. Sp. gr. 1·044. Acetates evolve odour of acetic acid on addition of H_2SO_4. *Impurities.*—Lead, copper; sulphuric, hydrochloric, and sulphurous acids.

Preparations.

1. **Acidum Aceticum Dilutum.**—1, to 7 of Distilled Water. *Dose*, 1 fl.dr. to 1 fl.oz.
2. **Oxymel.**—1; Water, 1; Honey, 8. *Dose*, 1 to 2fl.dr.

Acetic Acid is used in preparing :

Acetum Cantharidis, Acetum Scillæ, Extractum Colchici Aceticum, Liquor Morphinæ Acetatis, and many Acetates.

Acidum Aceticum Glaciale. — Glacial Acetic Acid. $HC_2H_3O_2$, Real Acetic Acid, 99 per cent., with Water.

Source.—Made by distillation from Acetate of Sodium and Sulphuric Acid. $NaC_2H_3O_2 + H_2SO_4 = HC_2H_3O_2 + NaHSO_4$.

Characters. — A colourless acid liquid, with a powerful acetic odour. Sp. gr. 1·058. Crystallises below 60° Fahr. *Impurities.*—Sulphurous acid; and water.

Glacial Acetic Acid is used in preparing :

Acetum Cantharidis, Mistura Creasoti, and Linimentum Terebinthinæ Aceticum.

Acetum.—Vinegar. Contains $HC_2H_3O_2$, 5·41 per cent.

Source.—Prepared from a mixture of malt and unmalted grain by the acetous fermentation. A little Sulphuric Acid is added, to make it keep.

Characters.—A brown-coloured acid liquid, with a characteristic odour. Sp. gr. 1·017 to 1·019. *Impurity.*—Excess of sulphuric acid, detected volumetrically. *Dose*, 1 fl.dr. to 1 fl.oz.

With Vinegar is made: Emplastrum Saponis Fuscum.

Acidum Citricum.—Citric Acid. $H_3C_6H_5O_7,H_2O$.

Source.—Obtained from the juice of the Lemon (Citrus Limonum), or of the Lime (Citrus Bergamia), by (1) neutralising the boiling juice with Chalk; (2) decomposing the Citrate of Calcium thus formed, mixed with water, by adding diluted Sulphuric Acid, boiling, and filtering; (3) concentrating and crystallising. (1) $2H_3C_6H_5O_7 + 3CaCO_3 = Ca_32C_6H_5O_7 + 3H_2O + 3CO_2$. (2) $Ca_32C_6H_5O_7 + 3H_2SO_4 = 2H_3C_6H_5O_7 + 3CaSO_4$.

Characters.—Colourless right rhombic prisms with an acid taste; very soluble in water. Soluble Citrates give a white precipitate when boiled with Lime-Water; no precipitate with $KC_2H_3O_2$. 20 gr. in ½ oz. of water makes a solution resembling lemon juice in strength and acidity; and neutralises 28½ gr. of Potassii Bicarbonas, 24 gr. of Sodii Bicarbonas, or 15 gr. of Ammonii Carbonas. *Impurities.* — Copper, sulphuric acid, mineral matters; tartaric acid, detected by precipitate with $KC_2H_3O_2$. *Dose*, 10 to 30 gr.

Citric Acid is used in preparing:

Liquor Ammonii Citratis Fortior, Bismuthi Citras, Lithii Citras, Potassii Citras, Sodii Citro-Tartras Effervescens, Ferri et Ammonii Citras, Ferri et Quininæ Citras, and Vinum Quininæ.

Acidum Tartaricum.—Tartaric Acid. $H_2C_4H_4O_6$.

Source.—Made by boiling Acid Tartrate of Potassium with Water; adding (1) Chalk till effervescence ceases, and (2) Chloride of Calcium; (3) decomposing the Tartrate of Lime with Sulphuric Acid; filtering off the Sulphate of Calcium; evaporating the filtrate, and crystallising. (1) $2KHC_4H_4O_6 + CaCO_3 = CaC_4H_4O_6 + K_2C_4H_4O_6 + H_2O + CO_2$. (2) $K_2C_4H_4O_6 + CaCl_2 = CaC_4H_4O_6 + 2KCl$. (3) $CaC_4H_4O_6 + H_2SO_4 = H_2C_4H_4O_6 + CaSO_4$.

Characters.—Colourless oblique rhombic prisms, with a strongly acid taste, readily soluble in water. An excess gives with KHO a white crystalline precipitate. Soluble Tartrates give a white precipitate with excess of Lime-Water. 20 gr. neutralise 26⅔ gr. of Potassii Bicarbonas, 22½ gr. of Sodii

Bicarbonas, or 14 gr. of Ammonii Carbonas. *Impurities.*—Lead, oxalic acid, lime, mineral matter, acid tartrate of potassium. *Dose*, 10 to 30 gr.

Tartaric Acid is used in preparing:

Sodii Citro-tartras Effervescens.

Carbonic Acid.—Although not official as such, Carbonic Acid Gas is extensively used in medicine, being obtained from Bicarbonates and Carbonates, commonly of Sodium, Potassium, or Ammonium, by decomposition with Citric or Tartaric Acid. The process is known as *effervescence*, and the reaction may be thus represented:

$$\begin{array}{ccccccccc} 3KHCO_3 & + & H_3C_6H_5O_7 & = & K_3C_6H_5O_7 & + & 3CO_2 & + & 3H_2O. \\ \text{Potassii Bicarbonas} & + & \text{Acidum Citricum} & = & \text{Potassii Citras} & + & \text{Carbonic Acid} & + & \text{Water} \end{array}$$

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Acids are irritants, and some of them very powerful corrosives. The strong acids are used as **caustics**: Nitric Acid to destroy chancres; Acetic Acid, warts; Sulphuric Acid, some forms of malignant growths. Very dilute watery solutions, sponged on the skin in fever, cool the surface by evaporation, and thus act as **refrigerants**; whilst watery solutions of Sulphuric Acid used in this way appear to constringe the tissues, and diminish the sweating of phthisis.

Internally.—In the dilute form, acids act directly upon the contents of the alimentary canal, and are used in the treatment of poisoning by alkalies. In every instance the free acids quickly unite with bases in the digestive tract, and form neutral salts. In the mouth they are **stimulants and sialagogues**: they rouse the appetite, and aid digestion by increasing the flow of saliva, and thus indirectly, as well as reflexly, of the gastric juice. Acids also relieve thirst; Citric, Tartaric, Acetic Acids, and Carbonic Acids in effervescence, as well as the mineral acids largely diluted with water, being chiefly used for this purpose in fever, and acid wines, drinks, and fruits in great variety. In the stomach Hydrochloric Acid increases the acidity of the gastric juice, and is given in dyspepsia during or after meals, as a **digestive adjuvant**. Carbonic Acid, introduced in effervescing wines and waters, has a grateful sedative action upon the gastric nerves; and in the form of champagne and effervescing mixtures is a most valuable remedy in the treatment of sickness with exhaustion. Reaching the duodenum, acids **increase the acidity of the chyme and stimulate the liver, pancreas, and intestinal muscles and glands.** Diluted Nitric and Nitrohydrochloric Acids, given at the end of meals, are therefore used as **cholagogues** in intestinal dyspepsia with hepatic torpidity, especially tropical cases. Sulphuric Acid, as the Diluted or the Aromatic Acid, is a valuable **intestinal astringent**, much employed in diarrhœa.

2. ACTIONS ON THE BLOOD, AND THEIR USES.

Acids **render the blood less alkaline** (but never acid, even in poisonous doses), by combining with part of the alkali of the liquor sanguinis. No special use is made of this property, Phosphoric Acid increases the phosphates in the red corpuscles. and is thus **hæmatinic**. The vegetable acids, when given as salts of the alkalies, have an important **deoxydising** effect on the blood. For example, Citrate of Potassium becomes converted in the blood into Carbonate of Potassium, Carbonic Acid, and water, a portion, however, of the Citric Acid always remaining unoxydised (see *Potassium*), thus: $2(K_3C_6H_5O_7) + O_{18}$ (in blood) $= 3(K_2CO_3) + 5H_2O + 9CO_2$. Citrates, Tartrates, and Acetates of Potassium, Sodium, Ammonium, etc., in the effervescing form, may therefore be used to set free in the blood the carbonates of the alkalies, which cannot be so conveniently or safely given in large doses by the stomach. The vegetable acids have been used in the treatment of scurvy, apparently with doubtful success; and in rheumatism, with equally questionable results beyond their action on the mouth, skin, and kidneys.

3. SPECIFIC ACTIONS AND USES.

In the tissues and organs each of the acids exhibits a specific action of its own. *Sulphuric Acid* is an **astringent** to the blood-vessels, and is a valuable remedy in hæmorrhage. *Nitric* and *Nitrohydrochloric Acids* are **cholagogue**, specifically as well as locally; *e.g.* when administered by means of a foot-bath (8 fl.oz. to one gallon of water), or of a compress wrung out of the solution and worn over the hepatic region. Tropical enlargements of the liver may thus be reduced. *Hydrochloric Acid* enters the tissues as chlorides, and no specific action or use can therefore be credited to the small doses which can be given of it. *Phosphoric Acid* also possesses no further influence on the tissues than that of increasing *pro tanto* the amount of phosphates, and possibly the growth of bones; and its value in constitutional diseases is probably due to its action on the red corpuscles, and to the bases with which it is combined (Iron, Lime, etc.). The **tonic** influence of acids is most probably referable to their stimulating effect upon the gastric and biliary functions. As we have seen, *Acetic*, *Citric*, and *Tartaric Acids* never reach the tissues, being decomposed in the blood unless given in large doses.

4. REMOTE LOCAL ACTION AND USES.

The acids, having chiefly entered into combination as neutral salts, or having been decomposed in the blood, produce remarkably little local action when they are escaping from the body in the secretions. Thus *Sulphuric Acid* is excreted chiefly by the kidneys, increasing very slightly the normal amount of sulphates; part probably escapes by the bowels as sulphates of sodium and magnesium; part possibly by the skin, this acid being an **anhidrotic** in night-sweating. *Phosphoric* and *Hydrochloric Acids* behave similarly. *Nitric Acid* is believed to be partly decomposed into ammonia, and thus actually to diminish, to a slight degree, the acidity of the urine. *Acetic*, *Tartaric*, and *Citric Acids* pass out of the body as carbonates, unless in excess, when they escape unchanged by the kidneys. The important point to be noted about all these acids, therefore, is that **they do not, to any considerable or useful extent, increase the free acidity of the urine**. It must be observed, however, that all the acids probably stimulate the kidneys and skin indirectly, by increasing the total amount of salts excreted.

Acidum Boricum.—Boric Acid. Boracic Acid. H_3BO_3.

Source.—Made by the action of Sulphuric Acid on Borax; or by the purification of native Boric Acid.

Characters.—In colourless pearly plates, odourless, with a slightly bitter taste; unctuous to the touch. A weak acid. *Solubility*, 1 in 25 of cold, 1 in 3 of boiling water; 1 in 5 of glycerine; 1 in 16 of spirit. A solution with alcohol and H_2SO_4 burns with a green flame. *Dose*, 5 to 30 gr.

Preparations.

1. **Unguentum Acidi Borici.**—1 with 6 of Hard and Soft Paraffin.

2. "Boracic Lint (*not official*)." Lint steeped in a boiling saturated solution, and dried.

3. "Boroglyceride (*not official*)." Boric Acid heated with Glycerine.

Borax.—Borax. Biborate of Sodium. $Na_2B_4O_7,10H_2O$.

Source.—Native. Also made by boiling together Boric Acid and Carbonate of Sodium.

Characters.—Large transparent colourless crystals, slightly efflorescent, weakly alkaline. *Solubility*, 1 in 22 of cold water; 1 in 1 of glycerine; insoluble in spirit. *Dose*, 5 to 40 gr.

Preparations.

1. **Glycerinum Boracis.**—1; Glycerine, 4; Water, 2.
2. **Mel Boracis.** — 2; Glycerine, 1; Clarified Honey, 16.

ACTION AND USES.

Externally, Boric Acid destroys low organisms, a solution of 1 in 800 preventing the development of anthrax bacilli. It is thus a valuable **antiseptic and disinfectant.** On the tissues it produces little or no irritation, and is therefore peculiarly adapted for use as a surgical dressing. The Lint is now extensively employed in the antiseptic system; and lotions, warm fomentations made from a boiling saturated solution, and the Ointment are now in very frequent use as applications to burns, wounds, and ulcers. As its action does not extend beyond the surface to which it is applied, Boric Acid is never used for dressing cavities. In the form of a powder, ointment, or glycerine, it relieves itching, and prevents the fœtor of perspiration.

Internally, Boric Acid is a gastro-intestinal irritant in large doses.

The action of Borax is very similar to that of the Acid. As the Glycerinum or Mel it is much used as a mild but efficient disinfectant in aphthous states of the mouth; and as a lotion in some forms of parasitic and itching skin disease.

Acidum Sulphurosum.—Sulphurous Acid. Sulphurous Acid Gas, SO_2, dissolved in Water, and constituting 5 per cent. by weight of the solution (6·4 per cent. of Real Sulphurous Acid H_2SO_3).

Source.—Made by heating Sulphuric Acid with Charcoal; and dissolving the gas in Water. $4H_2SO_4 + C_2 = 4SO_2 + 2CO_2 + 4H_2O$.

Characters.—A colourless liquid, with a pungent sulphurous odour. Sp. gr. 1·025. *Impurities.*—Sulphuric acid; mineral matters; excess of water, detected by volumetric starch and iodine test. Sulphites destroy the colour of solutions of $KMnO_4$; and evolve SO_2 with H_2SO_4. *Dose*, ½ to 1 fl.dr.

From Acidum Sulphurosum is made:

Sodii Sulphis. — Sulphite of Sodium. $Na_2SO_3, 7H_2O$.

Source.—Made by saturating a solution of Carbonate of Sodium or Caustic Soda with Sulphurous Acid Gas.

Characters. — Colourless transparent, monoclinic, efflorescent prisms; inodorous, with a sulphurous and cooling saline taste; feebly alkaline. *Solubility*, 1 in 4 of water; very readily in spirit. *Dose*, 5 to 20 gr.

Sodii Hyposulphis. — Hyposulphite of Sodium. $Na_2S_2O_3,5H_2O$. *In Appendix of British Pharmacopœia.*

Source.— Made by passing Sulphurous Acid Gas into a solution of Carbonate of Sodium, with Sulphur. $2Na_2CO_3 + S_2 + 2SO_2 + H_2O = 2Na_2S_2O_3 + 2CO_2 + H_2O$.

Characters.—Large colourless transparent crystals; odourless; with a cool, bitter, sulphurous taste. Soluble in 1½ parts of water. *Dose*, 10 to 60 gr.

The Solution is an official test for I and Cl.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Sulphurous Acid is a powerful **deoxydising** agent. Seizing on oxygen and water, it decomposes organic bodies, and at the same time produces upon them the **irritant** local effects of sulphuric acid, into which it is converted. It thus destroys low forms of living matter, including the organisms associated with fermentation, decomposition, and certain diseases, 1 part in 2000 of water being sufficient to kill bacteria. Sulphurous Acid is therefore applied to ringworm; to foul wounds; and some kinds of sore throat are relieved by a spray of the official Acid. Morbid fermentation in the stomach, attended by the growth of organisms, such as *penicillium* and *sarcina*, may be quickly arrested by doses of min. 5 to min. 60 of the official Acid; but the Sodium salt is a more convenient form for internal use, being decomposed by the acids of the stomach. Sulphites given in full doses become converted into sulphates, and act as purgatives.

2. ACTION ON THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTIONS.

Sulphites were once supposed to enter the blood and tissues, and to arrest morbid fermentation or fever processes within them. The evidence, however, is to the effect that

Sulphites are not absorbed as such, but as sulphates; and the benefit derived from them in fevers is probably due to the laxative and diuretic effects of the higher salts. The suggested decomposition of Hyposulphites into sulphites and free sulphur, and their consequent alterative and disinfectant action in phthisis and other diseases, appear to be equally unreal. Sulphites are excreted by the urine and bowels in the form of sulphates.

Dry Sulphurous Acid Gas, although not official, is very extensively used for fumigating infected rooms and clothing, being probably the most powerful, certain, and convenient of all **disinfectants**. Sulphur is burned on a shovel or plate, the outlets from the room having been carefully closed, excepting the door through which retreat is made.

Acidum Chromicum.—Chromic Acid. Chromic Anhydride (not a true acid). CrO_3.

Source.—Made by dissolving Bichromate of Potassium in Sulphuric Acid and Water; decanting from the Acid Sulphate of Potassium; heating the liquor with more Sulphuric Acid and Water; cooling and crystallising.

Characters. — Crimson needles, very deliquescent; inodorous; corrosive to the skin. Soluble in water; may explode with glycerine or alcohol. Mixed with cold alcohol, aldehyde is evolved, and a green residue of oxide of chromium remains. *Impurity.*—Sulphuric Acid.

Preparation.

Liquor Acidi Chromici.—1 to 3 of Water.

ACTION AND USES.

Chromic Acid is a powerfully oxydising body. It thus destroys the organisms and products of decomposition, and is an active **deodorant and disinfectant**, which may be used ($\frac{1}{2}$ gr. to the ounce of water) to wash foul or infected parts. It is also a strong **caustic**; and may be applied as a paste with water or as the Solution, to condylomata, warts, and syphilitic sores; or in weak solution (1 in 40) to ulcers of the tongue and mouth. Care must be taken to limit its action to the diseased part, as it has a great power of penetrating the tissues.

Acidum Nitrosum.—Nitrous Acid. HNO_2. (*Not official.*)

This acid is not itself used in medicine, but the Nitrites are active and valuable drugs. Those in use are Nitrite of Sodium and Nitrite of Amyl, as well as Nitrite of Ethyl in Sweet Spirit of Nitre. The Sodium salt will be noticed here; the others under their own heads at pages 174 and 181.

Sodii Nitris.—Nitrite of Sodium. $NaNO_2$. (*Not official.*)
Source.—Heating Nitrate of Sodium. $2NaNO_3 = 2NaNO_2 + O_2$.
Characters.—A white granular powder, deliquescent, with a cool saline taste, very soluble in water. *Impurities.*—The nitrate, and caustic soda. *Dose*, 2 to 10 gr.

ACTION AND USES.

Nitrite of Sodium acts upon the blood, the heart, and the vessels, **like Nitrite of Amyl**, only less suddenly and markedly, and for a longer period of time. (*See* page 181.) Its depressant action on the central nervous system is more marked than that of tho Amyl compound; and it paralyses the peripheral nerves and the muscles not only in this way, but through the blood. It has been used in heart disease with recurrent attacks of painful angina; less successfully in epilepsy.

Acidum Lacticum.—Lactic Acid. $HC_3H_5O_3$, with about 25 per cent. of Water.
Source.—Produced by the action of a peculiar ferment on solution of Sugar, and subsequent purification of the product.
Characters.—A pale yellowish, syrupy liquid, inodorous, with acid taste and acid reaction. Sp. gr. 1·21. Miscible in all proportions with water, spirit, and ether; nearly insoluble in chloroform. *Impurities.*—Mineral acids, sugar, lead, and iron.

Preparation.

Acidum Lacticum Dilutum.—15, with 85 of Water. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

Lactic Acid is of much physiological interest as a normal constituent of the gastric juice, and a product of muscular metabolism. Its medicinal action cannot, however, be turned to much therapeutical use. The Diluted Acid has been used with very uncertain results as a spray in croup and diphtheria, to dissolve the membranes. Internally, it may be given as a digestive adjuvant after meals in dyspepsia. Entering the blood as alkaline lactates, it is decomposed into carbonic acid; is excreted as such in the urine; and has been credited with a beneficial effect in catarrh of the bladder. It has also been given in diabetes, in doses of half a fluid ounce in a pint of water daily.

GROUP V.

WATER.

AQUA. WATER.

Natural Water, the purest that can be obtained, cleared, if necessary, by filtration; free from odour, unusual taste, and visible impurity.

From Aqua is made:

Aqua Destillata.—H_2O. Pure Water, obtained by distillation. Should always be used in preparing medicines.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Water acts chiefly as a means of applying heat or cold to the surface of the body, being readily obtained at any temperature that may be desired. To produce this effect, Water may be applied in the form of **baths** of all kinds: cold, cool, temperate, tepid, warm, hot, vapour, or variously medicated; also by sponging, douching, fomenting, etc. These subjects will be noticed in the third part of the work. Possessing these properties, Water is used externally for purposes of cleanliness; for either raising or lowering the temperature of the body; relieving pain, insomnia, and delirium; removing spasms or convulsions; diminishing the circulation in deep parts by superficial "derivation," as in congestion of the brain; etc. Water is also used, in a purely local way, as a wash or dressing to wounds, and as the basis of warm fomentations in inflammations.

Internally, Water is constantly being taken in the form of food and drink. It relieves thirst; improves digestion and intestinal action when drunk in moderation and at proper times;

and in a purely physical way may reduce the local or general temperature of the body, for instance, as ice slowly sucked in sore throat and febrile conditions.

2. ACTION ON THE BLOOD.

Water is quickly incorporated with the circulating plasma. Great excess has been known to dissolve part of the red corpuscles, but this is a purely pathological effect.

3. SPECIFIC ACTION AND USES.

Water plays an essential part in tissue life and in the activity of all the organs. A copious supply increases nutrition up to a certain point, especially the deposit of fat, and is therefore extensively employed in hydro-therapeutics.

4. REMOTE LOCAL ACTION AND USES.

Water is excreted by the kidneys, skin, lungs, bowels; indeed, necessarily in every secretion. Increase of Water in the urine is most readily induced when the skin is kept cool, and carries with it an excess of urea, phosphoric acid, and chloride of sodium. Water is thus a **diuretic**, and in one sense the most natural measure of the kind, being indicated when we desire simply to irrigate or flush the uriniferous tubules and urinary passages, and wash from them the products of disease, such as blood, leucocytes, cellular *débris*, and sediments. Some kinds of calculi may be dissolved by the steady consumption of Distilled Water, which carries away minute traces of the stone, whilst it prevents fresh accretion on the surface.

As a **diaphoretic**, Water acts best when warm and combined with external heat. It is the basis of most of our domestic measures for relieving feverishness by inducing perspiration, such as warm drinks of all kinds, and spirituous compounds.

GROUP VI.

THE CARBON COMPOUNDS.

Alcohol. Alcohol. C_2H_5HO.

1. **Alcohol Ethylicum.**—Ethylic or Absolute Alcohol. C_2H_5HO.

Source.—Made by macerating and shaking Rectified Spirit with Carbonate of Potassium; decanting;

macerating and shaking the liquid with freshly fused Chloride of Calcium; and distilling.

Characters.—Colourless, free from empyreumatic odour. Sp. gr. 0·797 to 0·800, containing 1, or at most 2 per cent. of water. Entirely volatilised by heat; boils at 173·6° Fahr. Gives a green colour with K_2CrO_4, CrO_3 and H_2SO_4, a sweetish odour being evolved. *Impurities.*—Resins or oils; detected by turbidity on dilution. Water; giving blue colour with anhydrous sulphate of copper.

Alcohol Ethylicum is used in preparing Chloroformum and Liquor Sodii Ethylatis.

2. **Spiritus Rectificatus.**—Rectified Spirit. Alcohol, C_2H_5HO, with 16 per cent. of Water.

Source.—Obtained by distillation of fermented saccharine fluids. $C_6H_{12}O_6$ (Grape Sugar) $= 2C_2H_5HO + 2CO_2$.

Characters.—Colourless, transparent, with a pleasant odour, and strong spirituous burning taste. Sp. gr. 0·838. Burns with blue flame without smoke. *Impurities.*—Water; tested volumetrically. Amylic alcohol, beyond a trace; detected by excessive reduction of $AgNO_3$. Resins or oils; giving turbidity on dilution with water.

Preparation.

SPIRITUS TENUIOR.—Proof Spirit. Alcohol with 51 per cent. by weight of water. Made by mixing 5 parts of Rectified Spirit with 3 parts of Water. Sp. gr. 0·920.

Spiritus Rectificatus and Spiritus Tenuior are also used in preparing many Tinctures, Spirits, Essences, Liniments, and other preparations.

3. **Spiritus Vini Gallici.**—French Brandy. Spirit distilled from French wine.

Characters and Composition.—A spirit of a light sherry colour, and peculiar flavour. Contains about 48 to 56 per cent. by volume of *alcohol*, with some *ethylic ether* combined with *acetic* and other *ethers*, and traces of *volatile oils*. Sp. gr. ·941.

Preparation.

MISTURA SPIRITUS VINI GALLICI.—"Brandy Mixture," "Egg-Flip." Brandy and Cinnamon Water, of each 4 oz.; Yolks of two Eggs; Sugar, ½ oz. *Dose*, 1 to 2 fl.oz.

4. **Vinum Xericum.**—Sherry. A Spanish Wine.

Characters and Composition.—Pale yellowish-brown. Contains about 17 per cent. of *alcohol; colouring matter, ethers, acid tartrate of potassium, malates, sugar, etc.*

Preparations.

The following Vina: Aloes, Antimoniale, Colchici, Ferri, Ipecacuanhæ, Opii, Rhei.

Vinum Aurantii is made by fermentation of a saccharine solution; Vinum Ferri Citratis and Vinum Quininæ are made from Vinum Aurantii.

Besides the foregoing preparations, which are commonly associated with Alcohol, all the Tincturæ, Spiritus, and Essentiæ, several of the Liquores, Linimenta, and Misturæ, and a few other compounds contain it in various proportions.

Amount of Alcohol (absolute, by weight) in various important substances containing it.

Alcohol Ethylicum, 98 to 99 per cent.
Alcohol (U.S.P.), 91 per cent.
Spiritus Rectificatus, 84 per cent.
Alcohol Dilutum (U.S.P.), 45·5 per cent.
Spiritus Tenuior, 49 per cent.
Spiritus Vini Gallici (Brandy), about 48 to 56 per cent.
Spiritus Frumenti (Whisky), about 44 to 50 per cent.
Rum ⎫
Gin ⎬ about 40 to 50 per cent.
Strong Liqueurs ⎭
Port, Sherry, and Madeira, about 14 to 18 per cent.
Vinum Album Fortius (U.S.P.), 20 to 25 per cent.
Vinum Album (U.S.P.), about 17·5 to 22 per cent.
Champagne, about 10 to 13 per cent.
Hock and Claret, about 8 to 11 per cent.
Vinum aurantii, 10 to 12 per cent.
Beer, about 3, 5, or more per cent.
Koumiss (made from milk), about 1 to 3 per cent.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Alcohol is an **antiseptic and disinfectant,** employed as a constituent of lotions for ulcers and wounds. In the form of Brandy it is rubbed into the skin to prevent bedsores, by hardening and disinfecting the epidermis. Applied in lotion to the skin, and free evaporation allowed, Alcohol is a powerful **refrigerant**, withdrawing heat from the body by its evaporation, blanching the parts by vascular constriction, and producing a sense of cold. In this form it is used to prevent or allay inflammations of superficial parts, such as the subcutaneous tissues, joints, and muscles; and to relieve pain, especially headache, due to vascular dilatation and throbbing. Spirituous lotions sponged on the skin also diminish the activity of the sweat glands, and may be used in excessive perspiration as an anhidrotic. On the contrary, if the vapour be confined and allowed to act upon the tissues underneath, or if the Alcohol be rubbed into the part, it penetrates and hardens the epithelium, and irritates the nerves and vessels of the cutaneous structures, causing redness, heat, and pain followed by local anæsthesia. Spirituous liniments containing soaps, essential oils, and other **stimulants** (*e.g.* Linimentum Camphoræ and Linimentum Camphoræ Compositum), are applied with friction to increase the nutrition of parts which are the seat of chronic inflammation, induration, adhesions, stiffness, and pain, such as the fibrous structures and muscles in chronic rheumatism, periostitis, and paralysis; or to produce a **rubefacient** effect on a large area of skin, of the surface of the chest, for instance, in bronchitis. Alcohol is absorbed by the unbroken skin.

Internally, the local action of Alcohol begins in the mouth with its characteristic taste, and a hot, painful, stimulating effect on the tongue and mucous membrane. If it be retained in contact with them, the epithelium becomes condensed and whitened, and the parts beneath anæsthetised. Some forms of toothache can thus be quickly and completely relieved, the Spirit also acting as a disinfectant in the pulp cavity. Wines and other wholesome alcoholic liquids, consumed during meals, have an action of the first importance on the nerves of the tongue, palate, and nose. By virtue of their taste, flavour, and bouquet, they **give a relish to food, increase the appetite, and stimulate the flow of saliva and the functions of the stomach.**

In the *stomach* the action of Alcohol is complex, and of great importance. (1) Alcohol mixes with the *contents* of the stomach; is partly decomposed into aldehyde and acetic acid; and precipitates some of the pepsine, as well as some of the peptones and proteids: so far it depresses digestion. (2) It stimulates the *mucous membrane*, dilating and filling the vessels with blood; excites and markedly increases the flow of gastric juice; sharpens the appetite; and renders the movements of the viscus more energetic: in these respects it greatly assists digestion. The total effect of a moderate dose of Alcohol is decidedly to favour **gastric digestion**, especially in cases where the nerves, vessels, and glands lack vigour, as in old age and in the chronic dyspepsia of persons weakened by acute illness, town life, and anxious sedentary employments. Herein consists the value of a small amount of wine or wholesome ale taken with meat meals by such subjects. The danger lies in excess, which readily destroys the activity of the juice, contracts the blood-vessels, and sets up a secretion of alkaline mucus which greatly interferes with digestion, a common cause of acute dyspepsia.

(3) The action of Alcohol on the gastric wall produces extensive effects of a *reflex* kind. The heart is stimulated by moderate doses, producing a pleasurable rise of blood pressure and a sense of power. The vessels dilate universally, filling the active organs with blood, which further increases their activity, the brain being specially excited and the skin flushed and warmed subjectively. If the quantity be large, these salutary effects of Alcohol as a **diffusible stimulant** may pass into depression; and the sudden ingestion of a large amount of spirit may prove rapidly fatal by shock. The reflex effects of alcoholic stimulants, if properly applied, add to their value at meal-times, by increasing the enjoyment of eating, and thus the digestive power. Certain forms of pain in the stomach and bowels are rapidly relieved by the local action of Brandy, which also helps to expel flatus; and pain, spasm, irregular or feeble action of the heart, cold feelings of the surface, and low conditions of the brain, are all quickly removed by the same reflex means, before the Alcohol can be absorbed in quantity into the blood.

2. ACTION ON THE BLOOD.

Alcohol enters the blood unchanged, or as aldehyde, and is distributed by it to the tissues and organs, a small part only becoming lost in it as acetic and carbonic acid. The action of Alcohol on the corpuscles is still obscure, but it probably **binds the oxygen more firmly to the hæmoglobin**, so that oxygenation of the tissues occurs less freely, and therefore less extensively. The effect of this upon metabolism will now be described.

3. SPECIFIC ACTION.

Alcohol is rapidly taken up by the various organs, chiefly unchanged. If given in moderate quantity, it is (1) oxydised in its passage through the tissues into carbonic acid and water like other carbohydrates, that is, it is a **food**, or source of heat and energy. At the same time it produces two other equally important effects; for (2) it **reduces the activity of metabolism** or the oxydation of the tissues; and (3) it first **stimulates**, and afterwards depresses, the circulatory and nervous systems, quite independently of its action on tissue change. These three effects of Alcohol must be discussed separately.

(1) *Alcohol as a food.*—It may now be accepted as proved that, when taken in sufficiently small quantities, **Alcohol is oxydised in the tissues**; and that it only passes out of the body unchanged, through the lungs, kidneys, etc., when so freely given that excretion occurs before oxydation has had time to take place. This decomposition of Alcohol must necessarily develop vital force and heat, like the oxydation of sugar, fat, and albumen. Alcohol belongs to that class of foods which do not become an integral part of the living cells, or "tissue proteids," as do much of the albumen, salts, etc., but remain in the plasma which bathes the cells, are oxydised there, and constitute their pabulum, the materials which supply the active elements with much of their energy, the "circulating proteids," carbohydrates, etc. Thus it happens that Alcohol can for a time sustain life when no food (so-called) is taken, as in confirmed drunkards and in some cases of severe illness. Professor Binz, of Bonn, who has studied this question with great industry and success, has calculated how much energy is contained in a gramme of Alcohol, and finds that two ounces of Absolute Alcohol yield about the same amount of warmth to the body as is supplied by an ounce and a half of Cod-liver Oil. The *uses* of Alcohol as a food will be presently described along with its other applications.

(2) *Alcohol as a nutritive depressant.*—Whilst it is itself thus oxydised in the tissues, **Alcohol unquestionably interferes with the metabolism or oxydation of other substances**, especially (it would appear) saving or sparing the wear and tear of the "tissue proteids," or formed protoplasm of the cells. This has been determined from three facts observed in animals supplied with moderate doses of Alcohol: first, that less oxygen is absorbed; secondly, that the temperature falls, and the albuminous tissues, whilst they do not waste, tend to degenerate into fat, so that the body as a whole grows fat and gross; thirdly, and chiefly, that the amount of urea, uric acid, carbonic acid, and salts excreted, is decidedly diminished. These are settled facts; the explanation of them is more difficult. The interference of Alcohol with the oxygenating function of the red corpuscle is one obvious cause of impaired metabolism; another is the extreme readiness of the Alcohol when it reaches the tissues to seize upon the oxygen which is there, thus robbing as it were the fixed elements of their necessary share, and arresting their decomposition at the middle stage of fat. This remarkable property of Alcohol of **saving tissue waste** is one

of the foundations of its employment in fever, to be presently discussed.

3. *Alcohol as a stimulant and narcotic.*—The *circulation* in every part of the body is stimulated by a moderate dose of Alcohol. The increase in the force and frequency of the heart, and the dilatation of the peripheral blood-vessels, which together constitute this **increased circulatory activity**, are both so far reflex effects from the mucous membrane of the stomach, as we have already seen; but they are also in part direct, the Alcohol affecting the nervo-muscular structures of the heart, the cardiac centre, possibly the vaso-dilator centres in the medulla and cord, and certainly the nervo-muscular tissue of the middle coat of the vessels. To these causes of circulatory excitement must be added the voluntary muscular movements, which are much exaggerated under the influence of Alcohol. When Alcohol is taken in large quantities, its stimulant effect on the circulation passes into depression, both reflex and direct; and death may result, in part at least, from cardiac failure.

Upon the *nervous system*, the first effect of Alcohol in moderate quantity is also one of stimulation. The **nervous centres are increased in vigour** from the highest to the lowest, and in the same order of sequence. The imagination becomes brilliant, the feelings are exalted, the intellect is cleared, the senses become more acute, the feeling of bodily strength and ability is raised, and some of the appetites are temporarily excited. The centres of speech, and of muscular movements generally, are specially exalted, giving rise to animated talk and lively gesticulations; and, therewith, a sense of *bien être*, referable to the combined nervous and circulatory excitement, spreads over the system.

If the dose of Alcohol be larger, these phenomena of stimulation are at first more pronounced, but very soon give place to **depression**, which spreads, like the excitement, from the highest to the lowest centres of the brain and cord. The intellectual, emotional, and voluntary faculties become first inco-ordinated, then dull, and finally completely arrested; the muscles are first **ataxic** and next paralysed, so that after an unsteady, staggering gait, the erect posture is impossible; and the consequent depression of the respiratory and circulatory centres leads to stertorous breathing, circulatory failure, and even death. The effects of Alcohol upon the nervous centres are referable partly to dilatation of the blood-vessels of the brain and cord, but certainly also to a direct action of the drug upon the nerve cells.

The action of Alcohol on the other bodily functions is chiefly, if not entirely, indirect. Thus, the *muscles* are affected solely through the nervous centres and nerves. *Respiration* is first increased, then slowed and weakened, partly through the special centre, but manifestly also, to a great extent, through the muscles and the circulation. Death occurs partly by asphyxia. **The bodily temperature is, on the whole, lowered** by Alcohol: (1) by increased circulation through the dilated peripheral vessels; (2) by increased perspiration; (3) by diminished metabolism; and (4) after large non-medicinal doses, by general depression. The sense of warmth is, on the contrary, increased by the flushing of the skin with blood; a condition which promotes bodily heat and comfort in a warm or moderately cool atmosphere, but causes rapid refrigeration, general vital depression, and possibly death, in low states of the external temperature.

4. SPECIFIC USES.

The uses to which the complex specific action of Alcohol may be turned are many, and of great importance:

Alcohol is employed in **fever**, and other acute wasting diseases, such as delirium tremens and acute mania. The indications in these conditions are to prevent or to make good the great waste of tissues associated with the disease; to sustain the heart and nervous system, which threaten to fail, as the frequent pulse and the delirium testify; and to promote the loss of heat, which is formed in excess, as indicated by the thermometer, the dry brown tongue, the sleeplessness, and the general restlessness of the patient. We have seen that these ends are all fulfilled to a certain extent by Alcohol. When the symptoms just mentioned appear, Brandy or other form of Spirit, and Wines of the strongest varieties, are given in a definite amount per diem, according to the height of the fever, the state of the pulse and heart sounds, the general strength, the ability to consume food, the previous habits, and the age of the patient. It must be distinctly understood, however, that Alcohol is by no means essential in every case of fever; the very opposite being the case. In delirium tremens (acute alcoholism), where food, in the ordinary sense of the word, can often be given with the greatest difficulty only, the very substance which, as a stimulant, has caused the disease, must be judiciously continued as a form of nourishment for a time.

In chronic diseases attended by great debility, want of appetite, and possibly sickness, as well as fever, such as pulmonary phthisis, Alcohol will also find its place as a true food and antipyretic.

As a **stimulant** the principal use of Alcohol is in connection with the heart. This, as we have just seen, is an important part of its action in fever. Of all remedies in threatening death by cardiac failure (syncope, fainting, hæmorrhage, shock), Spirits are the best, being at once available, convenient, rapid in their action, and almost invariably successful if recovery be possible. For this purpose, Brandy, Whisky, etc., should be given either pure or only slightly diluted, by the stomach, bowel, or under the skin. Hardly less valuable is Alcohol, given continuously in small regular doses, in chronic disease of the heart, when natural hypertrophy fails and dilatation ensues. Wine, Rectified Spirit, or various Tinctures, may be given in such cases.

In *nervous* depression Alcohol must be ordered with the greatest hesitation. In melancholia, or in despondency begotten by grief, anxiety, suspense, over-work, excess, and especially by indulgence in Alcohol itself, this drug affords only too ready relief, as also in neuralgia, hysteria and allied disorders, and sleeplessness ; and the recommendation of it by the practitioner is frequently abused, being employed as a pretext for continued intemperance. In such cases the best rule is to order a definite amount of some weak alcoholic drink, such as Ale or Claret, at meal times only ; but even this recommendation is by no means always safe. Severe pain, such as neuralgia, is often successfully relieved on the same principle. Some forms of sleeplessness are readily overcome by warm alcoholic draughts at bed-time, or malt liquors : but here again great discrimination is requisite in ordering the remedy.

5. REMOTE LOCAL ACTION AND USES.

Alcohol given in medicinal doses is, as we have seen, almost entirely oxydised in the system, less than 3 per cent. passing out unchanged, chiefly by the lungs, less by the kidneys, and least by the skin. This amount, however, includes ethereal and other complex bodies associated with Alcohol in Wines and Spirits ; by far the greater part of the Alcohol proper is excreted as carbonic acid and water.

The **diuretic** effect of Spirits, Wines, and especially Gin and Beer, is well known, and may sometimes be employed in medicine. The **diaphoretic** effect of Alcohol and its applications have been already sufficiently discussed under fever.

Circumstances modifying the action and employment of Alcohol.—The different alcoholic fluids act very differently, according to their strength ; their other constituents, already enumerated ; the presence of carbonic acid in them (sparkling drinks), which increases the rapidity of their action on the stomach and possibly of their absorption ; the degree to which they are diluted with water ; and the condition of the stomach as regards the presence of food. The age of the patient, the soundness of his kidneys and other eliminating organs, his habits as regards Alcohol, and the amount of exercise which he can take, must also be carefully estimated in ordering the remedy. In conditions of waste and exhaustion, especially febrile states and after operations, large quantities (even 1 pint of Brandy per diem) may sometimes be tolerated, apparently from the rapidity of oxydation of the Alcohol in the system.

Alcohol Amylicum.—Amylic Alcohol. Hydrate of Amyl, $C_5H_{11}HO$, "Fousel Oil," with a small proportion of other spirituous substances.

Source.—Contained in the crude spirit produced by the fermentation of saccharine solutions with yeast; separated in the rectification of such spirit; and redistilled at 253° to 260° Fahr.

Characters.—A colourless oily liquid, with a penetrating and oppressive odour, and burning taste. Sp. gr. ·818. Boils at 270°. Very inflammable. Sparingly soluble in water; freely in spirit, ether, and essential oils. Exposed to the air in contact with platinum black, it is slowly oxydised, yielding Valerianic Acid. (*See* page 303.) *Impurities.*—Other ethereal substances; detected by specific gravity and boiling point.

Amylic Alcohol is used only to prepare Nitrite of Amyl and Valerianate of Sodium.

Chloroformum. Chloroform. $CHCl_3$.

Source.—Made by (1, 2, and 3) distilling Rectified Spirit with Chlorinated Lime and Slaked Lime (oxydising and chlorinating the alcohol); thereafter (4) purifying by washing with Water and with Sulphuric Acid; agitating with Slaked Lime and Calcium Chloride, and redistilling; and lastly adding one per cent. by weight of Ethylic Alcohol. (1) $2C_2H_6O + O_2 = 2C_2H_4O$ (aldehyde) $+ 2H_2O$. (2) $C_2H_4O + 3Cl_2 = C_2HCl_3O$ (chloral) $+ 3HCl$. (3) $2C_2HCl_3O + Ca(HO)_2 = 2CHCl_3 + Ca\,2CHO_2$ (formate of calcium). (4) The sulphuric acid chars and removes hydrocarbons, without affecting the Chloroform; the lime frees it from acid, the chloride of calcium from moisture.

Characters.—A limpid, colourless, heavy, volatile liquid, of an agreeable ethereal odour and sweet taste. *Solubility,* 10 in 7 of spirit; freely in ether, olive oil, and turpentine; 1 in 200 of water, in which it sinks in heavy drops. Sp. gr. 1·49. Boils at 140° Fahr. Burns with a greenish flame. Heated with KHO, it is decomposed, Potassium formate and chloride being formed. *Impurities.*—Hydrocarbons; detected by green colour with sulphuric acid. Non-volatile compounds; detected by residue and unpleasant odour after evaporation. Acids. Free Chlorine. *Dose,* 3 to 8 min.

Preparations.

1. **Aqua Chloroformi.**—1 well shaken in 200 of Water. *Dose,* ½ to 2 fl.oz.

2. **Linimentum Chloroformi.**—1 to 1 of Camphor Liniment.

3. **Spiritus Chloroformi.** — "Chloric Ether." 1 to 19 of Spirit. *Dose,* 20 to 60 min.

4. **Tinctura Chloroformi Composita.**—2; Spirit, 8; Compound Tincture of Cardamoms, 10. *Dose,* 10 to 30 min.

5. **Tinctura Chloroformi et Morphinæ.**—Made by (1) dissolving 8 gr. of Hydrochlorate of Morphine, and 4 min. of Oil of Peppermint, in 1 fl.oz. of Rectified Spirit, adding 1 fl.oz. of Chloroform, and 2 fl.dr. of Ether; (2) mixing 1 fl.oz. of Liquid Extract of Liquorice, and 1 fl.oz. of Treacle, with 3 fl.oz. of Syrup, adding this to (1), and mixing thoroughly; (3) adding ½ fl.oz. of Diluted Hydrocyanic Acid; and increasing the volume to 8 fl.oz. by further addition of Syrup. 10 min. contain 1¼ min. Chloroform, ⅓ min. Ether, and $\frac{1}{48}$ gr. Hydrochlorate of Morphine. *Dose,* 5 to 10 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, and allowed to evaporate, Chloroform causes a sense of coldness, and depresses the terminations of the sensory nerves of the part, thus reducing sensibility or removing pain. If, on the contrary, the vapour be confined, or the Chloroform rubbed into the skin, it acts as an irritant, causing redness and even vesication, with a sense of heat and pain, followed by anæsthesia of the part. A similar effect is produced on all exposed mucous membranes. As a **local anæsthetic,** Chloroform may be applied on lint, covered closely with a wine-glass, *e.g.* in temporal headache; or in the form of the Liniment, or various combinations with Belladonna and other anodynes which are used for the relief of lumbago, neuralgia, etc. The student must understand, however, that the local anæsthetic effect of Chloroform bears a very inferior relation to its rapid and powerful action as a general anæsthetic.

When given by the mouth, Chloroform produces an intensely hot, sweet taste, which renders it useful in pharmacy to cover the nauseous, bitter, and astringent characters of many drugs. It may also be used to relieve toothache. Like Alcohol, it causes reflex salivation, and in this way, as well as by a **carminative** action on the stomach, the Compound Tincture, Spirit, and Aqua are useful adjuvants to stomachic and tonic mixtures, relieving pain, vomiting, and flatulency. In full doses it may give rise to vomiting, as is frequently seen after anæsthesia. The Tincture of Chloroform and Morphine is a substitute for "Chlorodyne," a popular sedative and intestinal astringent. A few drops of Chloroform inhaled from a sponge or piece of lint (quite apart from its action and use as a general anæsthetic), rapidly soothe the respiratory nerves, and may be employed to arrest spasm of the glottis, asthma, and spasmodic or dry useless cough attending irritation of the air passages.

2. ACTION IN THE BLOOD

Chloroform enters the circulation by the respiratory organs, stomach, and the unbroken skin, as well as subcutaneously. Chiefly as Chloroform, partly as various products, it mixes with the blood; but its action on the circulating blood is still obscure.

3. SPECIFIC ACTION AND USES.

Chloroform reaches the tissues very rapidly, especially if administered in the form of vapour freely mixed with air, as it always is when given as a **general anæsthetic**. Its most important action is exerted upon the central nervous system, and demands detailed description. Whilst this description of the subject of anæsthetics will have particular reference to Chloroform, it will also apply in a general way to other agents of the same class, especially Ether; important differences being noticed under each drug. The phenomena of general anæsthesia will first be noted; secondly, an analysis will be made of these; thirdly, the uses of Chloroform will be enumerated; and fourthly, the method of administering the anæsthetic, and certain necessary precautions, will be briefly indicated.

1. **Phenomena of Chloroform anæsthesia.**—*a. First stage.* The first effect of the inhalation of Chloroform on the nervous system is powerful **stimulation**, but almost from the commencement this is accompanied by a certain amount of disorder. The very first inspiration seems to rouse the cerebrum to increased activity, an effect due to the direct action of the anæsthetic on the nerve cells of the *convolutions*, partly, perhaps, to vascular disturbance. The highest centres are first and chiefly excited, so that the imagination and feelings immediately become exalted; always, however, with some confusion.

For a moment the senses may be quickened, but they are speedily disordered and depressed: vision, hearing, and touch become dulled, and a strange feeling of lightness, freedom, tingling, and numbness pervades the surface and the extremities. All these sensations are strictly central, probably convolutional, in origin.

At the same moment, or almost immediately after, the Chloroform rouses the *muscular centres*, and various gesticulations, spasms, or struggling movements may ensue.

The *medulla oblongata* is next affected, the *centres of circulation and respiration* being stimulated, so that the pulse and respiration become more frequent (although the latter is more shallow), the face flushed, the blood pressure raised. At this point the skin becomes moist; a red rash in irregular patches may appear on the neck and chest; and the pupils may dilate slightly.

These phenomena vary greatly in different instances, with the constitution and condition of the nerve centres, the temperament and habits of the individual; laughing or crying or noisy struggling being the prominent feature in many cases.

b. Second stage.—The second effect of Chloroform on the nerve centres is **depression.** The same parts continue to be affected by the drug; but their functions, instead of being increased or simply disordered, are first diminished, and at last perfectly arrested. Consciousness now ceases, with the appearance of heavy sleep. Perception and sensation are annulled: the patient sees nothing, hears nothing, feels no pain. For the same reason, reflex excitability is first diminished and then lost: irritation of any part by tickling or pinching induces no movements of the limbs; at last, even touching the cornea causes no reflex rolling of the eye-ball nor winking of the lids.

As the anæsthesia deepens, the automatic and reflex excitability of the cord and medulla is also diminished, and the phenomena that ensue affect all the parts supplied by these centres. The muscular tone is lost, and the voluntary muscles become paralysed and relaxed. The pupil is contracted, dilating on stimulation of afferent nerves. The heart and respiratory organs are no longer excited, but their centres in the medulla being now depressed, their action is laboured, the pulse falling in frequency (a striking change from the previous acceleration) and in strength, and the respiratory movements being slow, heavy, and attended by noise or stertor.

Now is the time for the surgeon to operate, anæsthesia being complete, whilst the depression of the vital functions is still within safe limits. The effects may be expected to begin to pass off in a few minutes if the administration be stopped;

and although the amount of Chloroform required to complete the second stage varies greatly with the subject and other circumstances, it may be said that from 1 to 4 fluid drachms will probably have been given up to this point.

c. Third stage.—Beyond the second stage or degree, Chloroform anæsthesia is highly dangerous, the further action of the drug being attended by complete **loss of all reflex excitability** of the cord and medulla. The sphincters relax, the pupils are widely dilated and fixed, the globes prominent. The respiratory centre is no longer irritable, and the movements of the chest become weaker, irregular, sighing, and finally cease. The cardiac centre fails, the heart beating irrogularly and feebly, and at last stopping in diastole, both from central and from direct nervo-muscular depression. The blood-vessels dilate, the pressure falls to zero, and the circulation has come to a standstill. It is obvious that the dircet effects of Chloroform on the respiratory centre are complicated towards the last by venosity of the blood. Death may occur through the heart, thruogh the respiration, or through both.

2. **Analysis of the phenomena of Chloroform anæsthesia.**—Chloroform anæsthesia affords us an excellent opportunity of studying the action of a drug upon the various centres of the nervous system, from the highest downwards. The first parts to be stimulated are the cerebral centres with mental functions, the control of the special senses and consciousness; and these are the first to be depressed and finally annulled. The lower cerebral and spinal centres are affected less and somewhat later, so that a certain degree of excitement of these accompanies the first cerebral depression; and the spinal centres being no longer controlled by the cerebral, irregular excessive movements of the limbs ensue. As the depression deepens in the spinal centres, the muscles are paralysed. Lastly, the lowest centres of all, those of organic life, connected with the heart, vessels, respiratory organs, and sphincters, situated in the medulla and cord, yield to the action of Chloroform. Although affected from the first, it is not until the higher parts have become completely overpowered that the functions of these vital centres are seriously impaired, and death threatens. It is on account of the safe order of invasion of the different centres by Chloroform, that it has been selected as the proper agent for temporarily arresting consciousness; we shall find that many other powerful drugs equally depress the nervous system, but in a direction exactly the reverse.

The *peripheral nerves* are affected last of all in general anæsthesia, and it must be repeated that the loss of sensibility to the knife is due to a *central*, not a peripheral, effect.

The *muscles* are finally affected directly, as well as through the nervous system. The pupil is dilated in the first stage, probably by stimulation of the sympathetic; and contracted in the second, and dilated in the third stage, by stimulation and paralysis respectively of the third nerve or its cerebral centre. The other involuntary muscles are less obviously paralysed, and the parturient uterus contracts freely in complete anæsthesia, with some loss, however, of vigour and regularity.

3. **Specific uses of Chloroform.**—The circumstances under which Chloroform anæsthesia may be employed are the following: (1) In *operations attended by pain.* These need not be particularised. (2) In *operations where muscular action or spasm has to be overcome:* reduction of herniæ, dislocations and fractures; catheterism. (3) In *diagnostic manipulations:* exploration of the abdomen externally and *per rectum.* (4) In *diseases attended by excessive pain*, especially biliary and renal calculus. (5) In *parturition*, in certain subjects and conditions, the degree of anæsthesia induced being generally slight until the moment of birth. (6) In *spasmodic diseases*, such as tetanus, hydrophobia, uræmia, puerperal convulsions, the *status epilepticus*, severe chorea, and hiccup.

4. **Method of administration, and principal precautions to be observed in Chloroform anæsthesia.**—This is a purely practical subject, to be learned by experience and not in theory. The student has frequent opportunities of witnessing the administration of anæsthetics by skilled persons, and he must closely and carefully observe every effect of the Chloroform upon the patient. He will do well to interpret every phenomenon as it arises, such as mental and muscular excitement, the character of the breathing, the colour of the countenance, and (if possible) the state of the pulse, into exact physiological terms, as explained above; as, for example, stimulation of the convolutions and cord, interference with the respiratory centre, etc. He will thus come to appreciate accurately the condition of the patient at any moment, and be prepared to assist in anæsthesia himself. A number of thoroughly practical points will then have to be learned: the selection of suitable cases for anæsthesia; the preparation of the patient; the choice of the anæsthetic and of an inhaler; the position of the patient; the method of watching the face, eyes, pulse, and respiration; the detection of unfavourable symptoms, and their immediate treatment; and, finally, the after-treatment of the case. All these and other matters connected with the administration of anæsthetics can be but briefly referred to in the following paragraphs:

a. Selection of cases.—Chloroform must be given with great caution to the aged and infirm, to persons subject to attacks of faintness or known to suffer from fatty degeneration or dilatation of the heart, to very fat and very anæmic persons, to epileptics, to chronic drunkards, to the subjects of extensive disease of the lungs or respiratory passages. Nitrous Oxide Gas or Ether must be preferred in such subjects, according to the length of the operation. Valvular disease of the heart with compensation suggests special care, but is not a contra-indication. Operations on the mouth, nose, or throat, attended by possible bleeding into the glottis, demand special precautions, whether by greater expedition, special postures of the patient, or even previous tracheotomy. It must never be forgotten, however, that when an operation is absolutely necessary, it can always be more safely performed with anæsthetics than without their aid; and that before the days of Ether and Chloroform, many persons died during operation from fear, faintness, and shock, the danger of which is completely removed or greatly diminished by anæsthetics.

b. Preparation of the patient.—Insensibility is more rapid when the stomach is empty. No solid food should therefore be given for at least six hours before the operation, which should, if possible, be performed early in the morning when digestion has been completed and the anæsthetic is rapidly absorbed. If the patient feel faint under these circumstances, a small quantity of brandy and water may be given before operation. Artificial teeth must be removed. The respiration and pulse should be carefully noted before commencing inhalation.

c. Selection of the anæsthetic: purity of the same.—The anæsthetic agents in general use at the present time are Chloroform, Bichloride of Methylene, Ether, and Nitrous Oxide Gas. Of these, Ether and Nitrous Oxide are unquestionably to be preferred, unless there be some special reason to the contrary. The purity of the drug is best ensured by purchasing it from well-established makers, and not attempting to test it for oneself; and the same manufacture should always be used, if possible. It may be advisable to commence with one anæsthetic, and then, as circumstances alter during the operation, to change it for another.

d. Selection of the apparatus.—This will depend on circumstances and on the taste and experience of the administrator. Whilst elaborate inhalers are used in hospitals, it is satisfactory to know that the simplest apparatus may be equally safe, such as a handkerchief or towel made into a cone; care being taken that the Chloroform vapour is mixed very freely with air, but that in the case of Ether the atmosphere is excluded as completely as possible. A few capsules of Nitrite of Amyl and a pair of straight polypus forceps should be ready at hand.

e. Position of the patient.—The administrator must accommodate himself to the convenience of the operator, whose eye and hand must never be interfered with. If possible, the patient's head should be placed in such a position on the edge of a pillow that the saliva may flow from the mouth instead of into the stomach, and that the tongue may not fall back and produce dyspnœa. It is essential that the patient's chest and abdomen should not be compressed in the slightest degree by clothes or by the arms of the assistants, nor confined by bandages. The most comfortable position for the patient is on the side, with one hand and fore-arm beneath the pillow; and as a rule it is better to induce insensibility in this position, and afterwards arrange the patient for the surgeon, than to anæsthetise him in the constrained attitude often required in operations.

f. Administration.—The confidence of the patient should first be gained by a few minutes' conversation, whilst he is reassured as to the result and instructed how to breathe. When inhalation has commenced, the administrator must not, even for a single instant, cease to watch the face, respiration, and pulse. The degree of insensibility necessary for different cases varies greatly, the least being required for uterine, the most for rectal operations. The loss of the corneal reflex, and stertorous breathing, are generally employed as tests of insensibility, but no single sign can be relied upon. The smallest possible quantity of the drug should always be given; and patients once thoroughly anæsthetised by Ether may be kept under its influence for many minutes by rebreathing the air of expiration loaded with its vapour mixed with some fresh air.

g. Complications and unfavourable symptoms.—*Vomiting* is generally preceded by pallor of the face or a few deep inspirations. When it threatens, care must be taken that nothing is drawn into the larynx; the head should therefore be thrown forward, and the mouth opened by pressure on the symphysis of the jaw, or by inserting a pair of forceps between the teeth. Should vomited matter be inhaled into the respiratory passages and asphyxia threaten, laryngotomy must be immediately performed.

Lividity of the face and prolonged deep *stertor* should be checked by raising the shoulders, so that the diaphragm may descend more easily, and making the patient breathe fresh air. The position of the head is to be changed until respiration is more easy; the vessels of the head and neck must be allowed to empty themselves well and quickly; and the mouth may have to be opened to its fullest extent, which induces a deep inspiration, the following expiratory effort often clearing the larynx and fauces of tenacious mucus which had been obstructing the entrance of air.

Pallor of the face is to be combated by lowering the head and shoulders; if severe, by dropping the head over the end of the table. If this do not succeed, the vapour of Nitrite of Amyl should be given.

Shallow breathing, especially if intermittent, should be anxiously watched: and if it increase, artificial respiration should be at once resorted to, on no account waiting for the respiration to cease.

h. After-treatment.—Absolute quiet and keeping the eyes closed often prevent sickness after operation. If Ether have been given, the whole surface of the body having been carefully covered to prevent chill, the room should be cleared of the vapour as quickly as possible. Cough induced by Ether is often attended by blood-stained mucus, which, with these precautions, is of no consequence. Food should not be given within two hours after the operation, and for the first twelve hours should be entirely cold, and consist chiefly of soups and jellies, milk being avoided. A teaspoonful of burned brandy will often relieve the after-sickness when all other measures have failed.

4. REMOTE LOCAL ACTION.

Chloroform is excreted in part, as such, by the kidneys, lungs, mammary glands, and skin; part is lost in the system. No use is made of its remote effects, although small doses given by the mouth are said to increase all the secretions.

Æther.—Ether. Sulphuric Ether. $(C_2H_5)_2O$. A volatile liquid, containing at least 92 per cent. by volume of pure Ether, $(C_2H_5)_2O$.

Source.—Made by (1 and 2) distilling 50 oz. of Rectified Spirit, added in a continuous stream, with 10 oz. of Sulphuric Acid; (3) agitating with Slaked Lime and Chloride of Calcium in Water, and redistilling. (1) $C_2H_6O + H_2SO_4 = C_2H_6SO_4$ (sulpho-vinic acid) $+ H_2O$. (2) $C_2H_6SO_4 + C_2H_6O = (C_2H_5)_2O + H_2SO_4$. The process of etherification is thus continuous, sulphuric acid being re-formed and acting on a fresh quantity of spirit. *Heavy Oil of Wine* is also formed in the first part of the process, along with Ether and Water. This substance is either a mixture of Ethyl Sulphate $(C_2H_5)_2SO_4$, Ethyl Sulphite $(C_2H_5)_2SO_3$, and a polymeric form of Ethylene (C_2H_4); or a sulpho-vinate of a hydrocarbon radical. It smells somewhat like peppermint; is not soluble in water, but readily in alcohol and ether. Process (3) removes alcohol, water, and the oil of wine.

Characters.—A colourless, very volatile liquid, with peculiar strong odour and hot taste. It is entirely dissipated in vapour when exposed to the air, boils below 105° Fahr., and is very inflammable, with a white flame. It contains 8 per cent. of spirit. Sp. gr. 0·735. *Impurities.*—Alcohol; tested by sp. gr. Oil of Wine, giving odour on evaporation. Free Acid. *Dose,* 20 to 60 min.; *by inhalation,* 4 or 6 dr. to several oz.

Preparations.

1. **Æther Purus.**—Pure Ether. Oxide of Ethyl. Ether, $(C_2H_5)_2O$, free from alcohol and water.

Source.—Made by shaking Ether with Water, decanting; letting the washed Ether stand with fresh Lime and Chloride of Calcium; and distilling.

Characters.—Sp. gr. 0·720; boils at 96° Fahr. *Impurities.*—Alcohol and water; detected by sp. gr.

2. **Spiritus Ætheris.**—Ether, 1; Rectified Spirit, 2. Sp. gr. 0·809. *Dose,* 30 to 90 min.

From Spiritus Ætheris is prepared:

Tinctura Lobeliæ Ætherea. See *Lobelia.*

3. **Spiritus Ætheris Compositus.** — Hoffmann's Anodyne.

Source.—Made by (1) distilling 36 fl.oz. of Sulphuric Acid with 40 fl.oz. of Rectified Spirit, after the liquids have been mixed for twenty-four hours. (2) Shaking the distillate with Lime-Water to neutralise any acid; removing the supernatant liquor; and exposing it to the air for twelve hours, to evaporate the Ether. Lastly, pouring 3 fl.dr. of the resulting Oil of Wine into a mixture of 8 fl.oz. of Ether and 16 fl.oz. of Rectified Spirit. *Dose,* 30 min. to 2 fl.dr.

Ether is also used in making Collodion and Tinctura Chloroformi et Morphinæ; and in many pharmaceutical processes.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—When allowed to evaporate, Ether is a powerful **refrigerant and local anæsthetic,** abstracting heat and depressing the nerves of the part. It is used in the form of Dr. Richardson's spray to relieve the intense local pain of neuralgia, and more frequently to prevent pain in minor surgical operations, the parts being completely frozen in the course of a few minutes by a spray of Pure Ether from a proper apparatus. If the vapour be confined, or the Ether rubbed into the skin, a **rubefacient or vesicant** effect is produced, as with Chloroform.

Internally.—Ether has a powerfully burning disagreeable taste, and causes local irritation and reflex **salivation** in the mouth, like Chloroform. Reaching the stomach, either in the pure form, or as the simple or Compound Spirit, it acts as a local **stimulant** to the blood-vessels, nerves, and muscular coat, and is therefore used as a **carminative**, relieving pain and sickness and expelling flatulence, especially in nervous subjects. At the same time, it acts reflexly from the gastric mucosa upon the bowels, heart, and respiratory organs, as a powerful **systemic stimulant**. It is a very useful ingredient of **anti-spasmodic** draughts, as will be presently described. Given with Cod-liver Oil, it renders it more palatable to some patients, and more digestible, possibly by stimulating the pancreas.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Ether is absorbed into the blood with remarkable rapidity, and probably acts here like Chloroform.

The specific action of Ether and its employment as an **anæsthetic** so closely agree with those of Chloroform, that the reader is referred to their description under the latter drug. Only the important differences between the two substances require to be mentioned here. These are:

1. Ether must be administered nearly pure, say 70 per cent. of the vapour with 30 per cent. of air; whilst but 3 to 4 per cent. of Chloroform is given, with 97 or 96 per cent. of air.
2. With Ether the stage of stimulation is more protracted; there is more struggling; and the stage of anæsthesia is shorter and the degree less profound. Ether is therefore said to be safer, but less convenient, than Chloroform.
3. Ether depresses the heart and vessels less than Chloroform, the heart continuing to beat after respiration has been arrested by an excessive dose. The respiratory centre is also less depressed. For these reasons, also, Ether is called a safe anæsthetic.
4. Ether has a much less pleasant smell than Chloroform.

In choosing between Ether and Chloroform, preference must be given to the **safer anæsthetic**, and the use of Ether has accordingly been much revived the last few years. Under certain circumstances Chloroform is preferable, as in operations about the mouth, Ether causing a profuse secretion of ropy mucus; in operations where a light or cautery might come into contact with the Ether vapour and cause an explosion; in operations which must be hastily undertaken and completed; and in parturition, where profound anæsthesia is unnecessary. Infants bear Chloroform better, and their delicate respiratory passages are less irritated by it than by the pungent vapour of Ether.

Given by the mouth in small doses, Ether increases the activity of the circulation and nervous system; in part, as we have seen, by reflex action from the gastric wall, in part specifically; and is used as a powerful and rapidly **diffusible stimulant and antispasmodic.** As the Spirit, as Hoffman's Anodyne, or hypodermically, it is given in cardiac failure, angina pectoris, palpitation, and depression, being even more rapid in its effects than Alcohol, but more evanescent and of course less available in emergencies. Its antispasmodic powers make it useful in hysterical and epileptic threatenings; and in spasmodic cough and asthma it is one of the most valuable remedies during the seizure.

3. REMOTE LOCAL ACTION AND USES.

Ether is excreted like Chloroform, and to a certain extent increases all the secretions, but is not employed with this end in view. It is believed by some to diminish the liability to gall stones, or actually to dissolve concretions already formed.

Nitrous Oxide Gas.—N_2O. "Laughing Gas." (*Not official.*) Although not a Carbon compound, Nitrous Oxide Gas will be discussed here, being closely allied therapeutically to Ether and Chloroform.

Source.—Made by heating Nitrate of Ammonium to 350° or 450° Fahr., and washing the gas. $NH_4NO_3 = N_2O + 2H_2O$.

Characters.—A colourless inodorous gas. It is provided for use condensed into a liquid, in strong iron bottles, whence it is allowed to escape into a caoutchouc bag.

ACTION AND USES.

1. ACTION ON THE BLOOD AND ITS USES.

Nitrous Oxide Gas, administered from an inhaler, rapidly enters the circulation; is absorbed by the plasma; converts the arterial into venous blood, in the course of about sixty seconds; and thus **produces partial asphyxia.** It does so apparently by diminishing the amount of oxygen in combination with the red corpuscles, without itself uniting with the hæmoglobin, like CO and NO; in this respect it is an "indifferent" gas, like N and H, simply taking the place of the oxygen, if this be completely excluded at the same time, and exerting of itself no poisonous action upon the corpuscles. It must, therefore, be given pure, *i.e.* without any admixture of air. The effect of the incipient asphyxia, and the use to which it may be turned, will be described in the next section.

2. SPECIFIC ACTION AND USES.

Nitrous Oxide Gas not only renders the blood venous, but simultaneously enters the nervous centres, upon which it acts, first as a stimulant, and speedily as an **anæsthetic**. Thus the gas produces a series of phenomena which can be resolved into the parallel effects of venosity of the blood or asphyxia, and a specific influence on the nerve cells of the convolutions. After a few seconds' excitement, the subject of anæsthesia by Nitrous Oxide begins to breathe laboriously; the mind becomes rapidly obscured; and, by the end of sixty seconds or more, consciousness is lost, the face becomes somewhat livid, respiration becomes stertorous, the pulse feeble at the wrist, and muscular twitchings occur. If the inhalation be now interrupted, perfect recovery of consciousness and of natural breathing occurs in thirty to sixty seconds, with disappearance of all the urgent symptoms. It is clear that asphyxia is carried into the second stage, that of respiratory excitement, but not beyond, neither the movements of the chest nor the action of the heart being arrested. But even if these untoward results should occur, resuscitation is easy by means of artificial respiration; it is said even after five minutes in the case of rabbits.

Nitrous Oxide Gas is extensively used to produce anæsthesia during operations lasting but one minute or less, and especially by dental surgeons during the extraction of teeth, destruction of the nerve, etc. It must always be given pure, by the arrangement above described in the hands of a skilled anæsthetist. The moment for operating is best indicated by stertorous breathing and twitching of the muscles. Persons with diseased vessels, such as the subjects of chronic Bright's disease, ought not to take this anæsthetic, which produces (like all asphyxiating agents) a great and sudden rise of the arterial pressure, liable to cause rupture within the brain.

Dichloride of Ethidene. (*Not official.*)

Source.—Obtained in the manufacture of Chloral.

Characters.—A colourless volatile liquid, with the odour and taste of chloroform. Sp. gr. 1·20. Readily soluble in ether, chloroform, and alcohol; with difficulty in water.

ACTION AND USES.

Dichloride of Ethidene is a **general anæsthetic**, supposed to occupy a position somewhat between Ether and Chloroform, but depressing the heart even more than the latter. About 4 fl.dr. in the form of vapour are required for an adult. It may be a safe anæsthetic in some animals, but, like all its allies, has caused death in man, and is now seldom given.

Æthyl Bromidum. (*Not official.*) Bromide of Ethyl. Hydrobromic Ether. C_2H_5Br.

Source.—Made by adding Bromine to a mixture of Phosphorus and Absolute Alcohol, and distilling. $3C_2H_6O + PBr_3$ (bromide of phosphorus) $= 3C_2H_5Br + H_3PO_3$.

Characters.—A colourless liquid with a powerful fragrant odour, and a hot sweetish taste. Very volatile; sp. gr. 1·42. Non-inflammable. Readily decomposes, yielding bromine. Freely soluble in alcohol and ether; very sparingly in water. *Dose*, 10 to 60 min.

ACTION AND USES.

Bromide of Ethyl acts as an **anæsthetic** like Chloroform and Ether. For a time it was used in America and England, especially in short painful operations and in ophthalmic practice, as its action is rapid and evanescent, and sickness rare. More than one death during or after its administration must account for its loss of popularity. It is also used as an antispasmodic in convulsions, and as a **local anæsthetic.**

Bichloride of Methylene. (*Not official.*) Dichloromethane. CH_2Cl_2. $(CH_2Cl.Cl)$.

Source.—Obtained from Chloroform by the action of nascent Hydrogen, one atom of which replaces one atom of Chlorine in the Chloride of dichlor-methyl (chloroform), $CHCl_2,Cl$.

Characters.—A colourless volatile liquid, with an odour like chloroform. Sp. gr. 1·344. Soluble in water, ether, and alcohol.

ACTION AND USES.

Bichloride of Methylene acts as a **general anæsthetic** very much like Chloroform. It is said, however, to depress the heart even more than this substance. It is now very seldom used for purposes of general surgery, but is frequently employed in ovariotomy.

Liquor Sodii Ethylatis.—Solution of Ethylate of Sodium.

Source.—Made by dissolving 1 part of Metallic Sodium in 20 parts of Ethylic Alcohol.

Characters.—A colourless syrupy liquid, becoming brown by keeping. Sp. gr. 0·867. Contains 19 per cent. of the solid salt, NaC_2H_5O.

ACTION AND USES.

Sodium Ethylate is a powerful **caustic**, used to destroy small accessible tumours, such as nævi.

Spiritus Ætheris Nitrosi. — Spirit of Nitrous Ether. A spirituous solution, containing nitrous compounds, aldehyde, acetic ether, acetic acid, and other substances.

Source.—Made by distilling a mixture of Rectified Spirit, Nitric Acid, Sulphuric Acid, and Copper; and dissolving the distillate in Spirit. Production of *Ethyl-Nitrite:* $C_2H_6O + HNO_3 + H_2SO_4 + Cu = C_2H_5NO_2$ (Ethyl-nitrite) $+ CuSO_4 + 2H_2O$. Production of *Aldehyde:* $C_2H_6O + O = C_2H_4O$ (Aldehyde) $+ H_2O$. Production of *Acetic Ether : see* page 176.

Characters.—Transparent and nearly colourless, with a slight tinge of yellow; mobile; of an apple-like odour, and a sweetish cooling sharp taste. Slightly acid. Inflammable. Sp. gr. ·840 to ·845. *Incompatibles.*—Iodide of potassium, sulphate of iron, tincture of guaiacum, gallic and tannic acids. Emulsions are curdled by its addition. *Impurity.*—Excess of acid; effervescing much with $NaHCO_3$. *Dose,* ½ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

In the stomach Spirit of Nitrous Ether is a **diffusible stimulant and carminative**, doubtless from the amount of alcohol which it contains.

2. ACTION ON THE BLOOD.

The Nitrite of Ethyl appears to produce the same effect on the red corpuscles as other Nitrites, especially diminishing oxygenation. *See* AMYL NITRIS, page 181

3. SPECIFIC ACTION AND USES.

Although anæsthetic to a degree, Sweet Spirit of Nitre chiefly acts upon the circulation, like Amyl Nitrite. It relaxes the peripheral vessels and accelerates the heart, but much less quickly, less completely, and more persistently than the Amyl compound. Thus it **lowers arterial tension**, and causes the phenomena described at page 181, only in a much less degree. By relaxing the renal vessels it is diuretic, the water being increased ; by dilating the cutaneous vessels, as well as by stimulating perspiration, it increases the loss of heat from the skin. Nitrous Ether is chiefly used as an **antipyretic** in febrile affections, where it diminishes the heat production by acting on the blood, and increases the loss of heat through the skin and kidneys. As a **diuretic** it is useful when a free watery flow is desired, to wash out the tubules and passages and relax spasm in the renal vessels, as in some cases of Bright's disease with increased arterial tension. Probably for the same reason it fails as a diuretic in cardiac dropsy, where the veins demand relief, and the arterial pressure is already too low. Being a dilator of the renal vessels, it must not be used in acute inflammatory states of the kidney. Spirit of Nitrous Ether may also relieve angina pectoris, and cardiac pain dependent on a failing and dilating heart in chronic Bright's disease. Like other Nitrites, it has benefited some cases of dysmenorrhœa and of asthma.

Aldehyde, one of the constituents of Spiritus Ætheris Nitrosi, and a colourless mobile liquid with an acrid suffocating odour, has a powerfully stimulant action on the cerebrum, followed by anæsthesia with respiratory depression.

4. REMOTE LOCAL ACTION.

Sweet Spirit of Nitre or its constituents are chiefly excreted by the kidneys and lungs. Its diuretic influence has just been described.

Paraldehyde.—(*Not official.*) $C_6H_{13}O_3$. A polymeric modification of Aldehyde.

Source.—Made by treating Aldehyde with Sulphuric or Nitric Acid.

Characters.—A colourless liquid, becoming solid below 50° Fahr. Odour and taste disagreeable, like Aldehyde. *Solubility*, 1 in 10 of water. *Dose*, 30 to 60 min. in water with syrup.

ACTION AND USES.

Paraldehyde is a pure **hypnotic,** like Chloral, but is believed to produce less depression of the heart than this drug, and therefore to be safer in the insomnia of cardiac disease. Custom, unfortunately, is readily established.

Urethan.—(*Not official.*) Carbamic Ether. $C_3H_7NO_2$ or C_2H_5,NH_2CO_2. — White inodorous crystals, with a pleasant taste like nitre; readily soluble in water. *Dose,* 4 to 8 gr. repeated; or 15 gr. at once.

ACTION AND USES.

Urethan has been recently introduced as a **hypnotic,** said to be less depressing to the circulation than Chloral, a respiratory stimulant, and more pleasant and active than Paraldehyde. It is excreted in the urine as urea.

Æther Aceticus.—Acetic Ether. Acetate of Ethyl. $C_2H_5,C_2H_3O_2$.

Source.—Made by (1) distilling Rectified Spirit with Acetate of Sodium and Sulphuric Acid; (2) digesting with dried Carbonate of Potassium; separating the ethereal liquid, and again distilling. $C_2H_5,HO + NaC_2H_3O_2 + H_2SO_4 = C_2H_5,C_2H_3O_2 + NaHSO_4 + H_2O$.

Characters.—A colourless liquid, with an agreeable ethereal, somewhat acetous odour, and refreshing taste. Sp. gr. about 0·900. Neutral. Boils at 166° Fahr. Soluble freely in spirit and ether, and in about 10 parts of water. *Dose,* 20 to 60 min.

Acetic Ether is used in making Liquor Epispasticus.

ACTION AND USES.

Acetic Ether is a **stimulant and antispasmodic,** much like Ether itself, but forms more agreeable combinations with other **carminatives** on account of its pleasant odour and taste.

Chloral Hydras.—Hydrate of Chloral. C_2HCl_3O, H_2O.

Source.—Made from Chloral, an oily liquid, by the addition of Water. Chloral C_2HCl_3O is itself made by saturating Anhydrous Alcohol with dry Chlorine Gas, and purifying.

Characters.—Colourless crystals, with a peculiar pungent agreeable odour, and a pungent, rather bitter taste. Readily fused by gentle heat, recrystallising on cooling to 120°. *Solubility :* very freely in distilled water, rectified spirit, and ether; 1 in 4 of chloroform. Forms a fluid when rubbed with an equal weight of camphor. *Incompatibles.*—All alkalies, which decompose it. (*See* below.) *Impurities.*—Hydrochloric acid, detected by test paper; oily substances, colouring sulphuric acid when the Chloral is dissolved in chloroform. *Dose*, 5 to 30 gr.

Preparation.

Syrupus Chloral.—10 gr. in 1 fl.dr. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied in weak solution (5 gr. to 1 fl. ounce of water), Chloral Hydrate is antiseptic; concentrated solutions are irritant, causing vesication, possibly troublesome sores. In this form it is but little used externally. The compound with Camphor is a valuable **anodyne**.

Internally.—The Chloral and Camphor compound quickly relieves some kinds of toothache. In the stomach Chloral is irritant unless freely diluted. It has no specially sedative effect on the stomach or bowels like Opium.

2. ACTION IN THE BLOOD.

Chloral enters the blood as such, and probably leaves it for the tissues without decomposition, although Liebreich, who introduced it into the materia medica, contended that it is broken up into chloroform and formic acid in the presence of the sodium salts of the plasma: $C_2HCl_3O + NaHO = CHCl_3 + NaCHO_2$. The blood undergoes no appreciable change.

3. SPECIFIC ACTION AND USES.

The action of Chloral upon the system so nearly resembles that of Chloroform, and the chemical relations of the two substances are so close, that Liebreich's theory is at first sight extremely plausible. Chloral chiefly affects the nervous system, although one of the principal dangers connected with its use depends on its direct action on the heart. Given in moderate doses (20 to 30 gr.), Hydrate of Chloral, after a very brief period of excitement, quickly induces drowsiness, followed by several hours' sound sleep, natural in its character and refreshing in its effect; as a rule, without consequent confusion, headache, or drowsiness in healthy individuals. Larger doses produce deeper and more prolonged sleep, and an appearance of narcosis, the subject being difficult to rouse even by sharp stimulation. Thus far Chloral manifestly acts upon the convolutions, either directly or through the cerebral circulation, or both; and is a **pure and powerful hypnotic.** The larger doses, however, enable us to appreciate its action, like that of Chloroform, on the lower nervous centres. The motor centres are depressed, whence diminished reflex excitability and relaxation of the muscles. The three great medullary centres are decidedly depressed: respiration becomes slow, irregular, and shallow; the heart is weakened (but chiefly in another manner, as we shall presently find); and the vaso-motor centre is lowered in activity, so that the vessels dilate generally. The peripheral sensory nerves are not specially affected. Neither are the motor nerves, nor the muscles, directly depressed.

Upon these several effects of Chloral depend at once its value medicinally, and the drawbacks or even dangers which occasionally attend its employment. It is the most rapid, and probably the most powerful, whilst the most pure of all the hypnotics, Opium not excepted. It is therefore extensively used to produce sleep and soothe the cerebral hemispheres in conditions of excitement; in insomnia from over-work, distress, maniacal excitement, or despondency; and in the early stages of fevers or febrile diseases, whilst the heart is still strong. It is especially valuable in delirium tremens. In the sleeplessness which attends or is caused by peripheral pain, Chloral fails, for an obvious reason; or if sleep be secured by a powerful dose, the patient wakes to suffering as before. It is totally unfitted to relieve the severe pain of neuralgia.

Chloral has also been given in the delirium of the more advanced stages of fevers; to relieve the distress, dyspnœa, and insomnia of cardiac and renal disease; and in the cough, spasm, and breathlessness attending phthisis, bronchitis, and other respiratory affections. The dangers of the drug in these conditions have been shown by the fatal results which have followed its employment; and the cause of them is obvious. Besides its depressing effect on the medulla, Chloral in full doses acts as an intrinsic cardiac poison, slowing and enfeebling the heart by diminishing the irritability of its ganglia, and finally arresting it in ventricular diastole. At the same time the blood pressure falls by peripheral paralysis of the vessel walls, as well as from the interference with the vaso-motor centre, the heart, and the respiration, already described; so that altogether the circulation tends to become arrested. Thus the relief to be obtained from Chloral in the delirium of fever where the heart is threatening to fail, and in organic disease of the heart, lungs, or kidneys, is but temporary and purchased at serious cost; for these purposes the drug cannot be recommended.

The action of Chloral in reducing the excitability of the grey matter of the cord and higher motor ganglia, has suggested its use in tetanus, strychnine poisoning, puerperal convulsions, hydrophobia, sea-sickness, and whooping cough. It has also been given in some cases of chorea, but here really as a hypnotic.

The exact effect of Chloral on metabolism is unknown. It reduces temperature, chiefly by increased loss of heat from the dilated peripheral vessels, but also by diminishing the production in the weakened muscles, etc. It may therefore be given with advantage as an antipyretic hypnotic at the commencement of fevers in strong subjects, its depressant action on the heart being carefully watched. It has been highly recommended in cholera.

4. REMOTE LOCAL ACTION.

Chloral is excreted by the kidneys partly unchanged, but chiefly as urochloral acid, $C_8H_{11}Cl_3O_7$, producing slight diuresis. Probably part escapes by the skin also, as a variety of eruptions may attend its prolonged use.

5. ADVANTAGES AND DISADVANTAGES OF CHLORAL; CAUTIONS; CONTRA-INDICATIONS.

It will be well to state here succinctly the advantages and disadvantages of Chloral as compared with Morphine (Opium). Chloral has the following *advantages:* It acts quickly as a hypnotic, even more quickly than Morphine subcutaneously; and more certainly, even when Morphine has failed. After-effects, such as headache, depression, and sickness are less common from Chloral. It does not derange the stomach, if freely diluted; nor cause constipation, even when given for a long time. It is more safely given, in proper doses, to children.

On the other hand, Chloral has these *disadvantages:* It does not relieve pain, and is thus greatly inferior to Opium in most cases as a hypnotic, and useless as an anodyne. It does not, like Opium, satisfactorily prevent or relieve distress, reflex dyspnœa, and cough due to heart and lung disease. Chloral causes excitement instead of quiet in many cases of mania, hysteria, and confirmed alcoholism.

Chloral must be given in relatively small doses to children and delicate persons; and very rarely, as we have seen, to the subjects of organic disease of the heart, lungs, and kidneys, or patients suffering from gout. If it excite instead of soothing the insane or the confirmed drunkard, it should not be persevered with; nor if it increase instead of relieving sleeplessness in certain individuals, as it does occasionally, apparently from idiosyncrasy. Lastly, Chloral must be prescribed with great hesitation to persons who suffer from constitutional debility of the nervous system, expressing itself in hysteria, despondency, excitability, and innumerable other forms. Such subjects very readily acquire the "Chloral habit"; that is, they consume on their own account regular and ever-increasing quantities of Chloral, until the nervous system and general nutrition fail, the mind is demoralised, and the victims ultimately perish liko the drunkard and the opium eater.

Butyl-Chloral Hydras. — Hydrate of Butyl-Chloral. Croton-Chloral. $C_4H_5Cl_3O,H_2O$.

Source.—Made from Butyl-Chloral by tho addition of Water. Butyl-Chloral, $C_4H_5Cl_3O$, is itself made by passing dry chlorine gas through aldehydo; and separated by fractional distillation.

Characters.—Pearly-white crystalline scales, with a pungent (not acid) odour, somewhat like that of Chloral Hydrate; and an acrid nauseous taste. *Solubility*, 1 in 50 of water; freely in spirit; 1 in 1 of glycerine. *Incompatibles.*—As of Chloral Hydrate. *Dose*, 5 to 15 gr.

ACTION AND USES.

In every important respect the action of Butyl-Chloral is nearly allied to that of Chloral, and it will thereforo suffice to indicate the points wherein the two drugs diffor.

Butyl-Chloral as a **hypnotic** is less rapid, less certain, and less powerful than the other, which is generally to be preferred for this purpose. It is believed that Butyl-Chloral is less depressant to the heart, and therefore that it may be given in insomnia with cardiac weakness where Chloral would be inadmissible. We must accept this recommendation with great caution. The most important effect of Butyl-Chloral, peculiar to itself, is **anæsthesia** of the region of the trigeminus, that is, of the face and part of the scalp, preceding the hypnotism. The drug relieves some cases of *tic-douloureux* and facial neuralgia very quickly; in some cases it fails. It has been given in other forms of pain in tho face, such as toothache (locally); in neuralgia of the limbs; and in painful menstruation.

Amyl Nitris.—Nitrite of Amyl. $C_5H_{11}NO_2$. A liquid consisting chiefly of Nitrite of Amyl.

Source.—Produced by distilling Nitric Acid with Amylic Alcohol and Sulphuric Acid and Copper; and purifying the product with Caustic Soda, Carbonate of Potassium, and fractional distillation. $HNO_3 + H_2SO_4 + Cu + C_5H_{11}HO = C_5H_{11}NO_2 + CuSO_4 + 2H_2O$.

Characters.—An ethereal liquid, of a yellowish colour, and peculiar pine-apple odour. Sp. gr. 0·880. Volatilises between 262° and 270° Fahr. *Solubility*, readily in rectified spirit, ether, and chloroform; insoluble in water. *Impurities.*—Free acid and nitrate of amyl.

Dose.—2 to 5 min., used with caution as inhalation from a crushed capsule; or ½ to 1 min. internally, dissolved in rectified spirit, 1 to 12.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Applied *directly* to peripheral nerves, Nitrite of Amyl depresses or paralyses them. It is never so employed in man. *Internally*, the drug is seldom given by the mouth, except in cholera.

2. ACTION ON THE BLOOD.

Nitrite of Amyl is usually administered by inhalation, a few drops being kept ready for use in a glass capsule (enveloped in cotton wool), which may be broken between the fingers and thumb when required. The vapour instantly enters the circulation through the lungs, converts a certain amount of hæmoglobin into methæmoglobin, and thus interferes with the oxygenating function of the red corpuscles; the amount of oxygen absorbed (in animals) being quickly lowered, as well as the excretion of carbonic acid. The blood of animals killed by Nitrite of Amyl is of a chocolate colour; but the effect of an ordinary inhalation in man is very transitory.

3. SPECIFIC ACTION AND USES.

Nitrite of Amyl almost instantaneously reaches the tissues (where the nitrous acid is possibly liberated), and produces striking phenomena. Two to five drops, inhaled as directed, immediately produce a sense of fulness and throbbing in the head; visible pulsation of the carotids; flushing of the face, neck, and trunk; increased frequency and force (that is, palpitation) of the heart; tingling over the surface generally;

dilatation of the pupils, and disturbances of vision; giddiness and unsteady gait; restlessness and anxiety of mind. These symptoms quickly disappear, possibly leaving slight headache. Larger doses aggravate all the phenomena, but never produce unconsciousness; mental confusion, intense bodily depression, coldness of the extremities, and sweats being the result, followed by severe headache, which may last for hours. Very rarely convulsions occur in man as in some of the lower animals.

The specific action of Nitrite of Amyl proves, on analysis, to be almost confined to the circulatory system, the other parts being chiefly involved secondarily. Two distinct effects are produced on the circulation. **The peripheral vessels are dilated**, by relaxation of their muscular coat; **the heart is greatly accelerated**, with but little, if any, increase of its force. Some authorities hold that the cardiac acceleration is due to depression of the cardiac centre, consequent on the fall of pressure; others to depression of the vagus in the heart. Some refer the vascular relaxation to the action of the Nitrite on the vasor centre in the medulla, others to its action on the vaso-motor nerves and muscular walls. Be this as it may, the fact remains that **the blood pressure falls** to a remarkable degree, that is, the resistance to the discharge of the left ventricle is correspondingly diminished; whilst this discharge is accomplished much more frequently within a given time. In other words, the left ventricle, under the influence of Nitrite of Amyl, has at once less work to accomplish, and more force wherewith to accomplish it; that is, is greatly relieved. These considerations led Dr. Lauder Brunton to employ the drug in those cases of the complex class of disease known as angina pectoris, in which agonising pain in the breast and neighbourhood is due to distension of the left ventricle, from its inability to empty itself against the pressure in the aorta, and in which fatal paralysis of the heart, or rupture of its walls, is the result of the unequal effort. Clinical experience has fully confirmed the value of Amyl Nitrite, in cases where spasm of the arteries is damming the blood back upon the ventricle, the channels being instantly opened and the ventricle rapidly emptied by the double effect of the drug. The pain of aneurysm of the aorta and various forms of cardiac disease and disorder, especially those dependent on high arterial pressure, as in Bright's disease, can often be relieved by Amyl Nitrite, but caution must be exercised in the first trial. Threatening death from cardiac paralysis in chloroform anæsthesia, and sea-sickness in which the blood pressure is greatly disturbed, are sometimes successfully treated with Nitrite of Amyl. Some cases of epilepsy, accompanied by spasm of the cerebral vessels and facial pallor, and of megrim or sick headache, due to similar spasm in the trigeminal area, are also benefited by this drug.

The reflex irritability of the cord is reduced (in animals) by Nitrite of Amyl, which has therefore been proposed as a remedy in poisoning by strychnine. Neither the peripheral nerves nor the muscles are affected when it is given through the blood. Respiration is disturbed, apparently by the alteration of the hæmoglobin and circulation, not through the nervous system. The Nitrite sometimes affords immediate relief in asthma, but the dyspnœa may as quickly return. The body temperature falls, from obvious causes.

4. REMOTE LOCAL ACTION.

Nitrite of Amyl probably escapes from the body by the urine, which is increased in amount and in acidity, and may contain sugar. These effects are probably due to local disturbances of the circulation in the kidneys and liver respectively. The drug has been given to increase the elimination of uric acid in gout, and to acidulate the urine in phosphaturia.

Nitroglycerinum.—Nitroglycerine. $C_3H_5(NO_3)_3$.

Source.—Made by dropping Glycerine into a mixture of Sulphuric and Nitric Acids, kept cool by ice; separating by pouring the product into water; washing; and evaporating to a proper density.

Characters.—A colourless oily liquid, odourless, with a sweet pungent taste. Sp. gr. 1·60. Slightly soluble in water; freely in fats, oil, alcohol, and ether. Highly explosive; and, when mixed with porous silica, constitutes dynamite. A Nitrate of Glyceryl. *Dose*, $\frac{1}{200}$ to $\frac{1}{50}$ gr. Never used undiluted.

Preparation.

Tabellæ Nitroglycerini.—Tablets of chocolate, each weighing two and a half grains, and containing $\frac{1}{100}$ of a gr. of pure Nitroglycerine. *Dose*, 1 or 2 tablets.

ACTION AND USES.

This substance closely resembles in its physiological action the Nitrite of Amyl, but is even more powerful, and its effects more persistent. Its activity appears to be due to nitrous acid formed by its decomposition within the body, Hay having shown that two-thirds of Nitroglycerine become reduced to nitrous acid by an alkali, forming a nitrite. It is used for the same class of cases as Amyl Nitrite, such as angina pectoris, chronic heart disease, sea-sickness, and asthma and other spasmodic disorders, some patients being more benefited by the one drug, some by the other. Nitroglycerine diminishes the amount of albumen in some cases of Bright's disease. It is absorbed by the unbroken skin.

Æthyl Iodidum.—(*Not official.*) IODIDE OF ETHYL. HYDRIODIC ETHER. C_2H_5I.

Source.—Made by adding Iodine to a mixture of Alcohol and Phosphorus, distilling, and purifying. $5C_2H_5HO + PI_5$ (iodide of phosphorus) $= 5C_2H_5I + H_3PO_4 + H_2O$.

Characters.—A colourless volatile liquid, with a peculiar powerful odour, and a pungent taste. Sp. gr. 1·94. Non-inflammable. Decomposed by light, yielding iodine. Soluble in alcohol and ether; very sparingly soluble in water.

Dose.—5 to 20 min., inhaled from a broken capsule.

ACTION AND USES.

Iodide of Ethyl acts chiefly by virtue of its Iodine element, and very slightly as an anæsthetic Ethyl compound. It introduces Iodine very rapidly into the system, and has been chiefly used to stimulate the respiratory passages, and thus to act as an **antispasmodic** in asthma attended by scanty or tough secretion. In some cases it gives instant relief.

Acidum Hydrocyanicum Dilutum. — DILUTED HYDROCYANIC ACID. "Prussic Acid." Hydrocyanic Acid, HCN, dissolved in water, and constituting 2 per cent. by weight of the solution.

Source.—Made by distilling aqueous solutions of Ferrocyanide of Potassium and Sulphuric Acid; and diluting the product with Water to the definite strength, as tested volumetrically with nitrate of silver. $2K_4Fe(CN)_6 + 3H_2SO_4 = 6HCN + Fe_2K_2(CN)_6 + 3K_2SO_4$.

Characters.—A colourless liquid, with a peculiar penetrating odour. Sp. gr. 0·997. Faintly acid. Treated in succession with liquor potassæ, solution of ferrous and of ferric sulphates; heated; and acidulated with HCl, it gives a green-coloured fluid, depositing Prussian blue. Treated with NH_4HS, and ferric chloride added after evaporation to dryness, it gives a deep blood-red colour. *Incompatibles.*—Salts of silver, copper, iron; red oxide of mercury, and sulphides. *Impurities.*—Sulphuric and hydrochloric acids. *Dose,* 2 to 8 min.

Preparations.

1. **Vapor Acidi Hydrocyanici.**—10 to 15 min. in 1 fl.dr. of cold Water.

2. **Tinctura Chloroformi et Morphinæ.** — $\frac{5}{8}$ min. in 10 min. (1 vol. in 16). See *Chloroformum,* page 161.

Hydrocyanic Acid is also contained in Aqua Laurocerasi. See also *Amygdala Amara.*

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied for a time to the skin, Diluted Hydrocyanic Acid causes numbness, directly **depressing the sensory nerves**. It is used, largely diluted, to relieve itching, but must not be employed where the surface is raw from scratching, as it is readily absorbed from wounds.

Internally, it produces a peculiar mixed sensation on the mouth and throat, and acts as a **sedative to the nerves of the stomach**. It is in common use to relieve gastric pain and arrest vomiting in painful dyspepsia, ulcer, and reflex or other nervous disorders of the stomach, *e.g.* in phthisis and pregnancy. The specific action of the drug on the medulla, to be presently described, doubtless assists its local effect upon the gastric nerves in producing these results.

2. ACTION ON THE BLOOD.

Hydrocyanic Acid enters the blood very rapidly from all parts, especially the lungs; and in poisonous doses produces an important change on the red corpuscles. It converts the blood of the veins first into a bright arterial colour, and then into a deep black, the former change arresting the oxygenating function of the corpuscles, the latter destroying them. These effects of Hydrocyanic Acid on drawn blood must not be too readily supposed to occur in the circulating fluid within the body, where its action in medicinal doses is chiefly local and specific.

3. SPECIFIC ACTION AND USES.

Hydrocyanic Acid rapidly enters the tissues, and acts chiefly upon the nervous structures. Considerable doses cause giddiness, faintness, nausea, a constricted feeling in the chest, headache, mental confusion, disturbed breathing, slowing of the pulse, and muscular debility. Larger doses aggravate these symptoms, and produce great dyspnœa and other signs of asphyxia; whilst in still larger quantity it is familiar as one of the most swift and deadly of poisons. Analysis proves that this drug, whilst **depressing all nervous tissues**, acts first and chiefly upon the *respiratory centre*, which is briefly excited and then depressed, leading to weak respirations with long pauses, dyspnœa, convulsions, and finally death by asphyxia. Simultaneously, the afferent branches of the *respiratory nerves* are depressed, especially if the acid be inhaled; and reflex respiratory acts are arrested. The *vaso-motor centre* is temporarily stimulated, and the blood pressure rises, but it falls again suddenly and greatly. The *cardiac centre* is the most resistant of the three, but it also is depressed, so that the action of the heart becomes less frequent and powerful. Although at the same time the nervo-muscular structures of the heart are depressed, the heart continues to beat in animals poisoned with Prussic Acid after the respiration and other functions have ceased. The *convolutions* are depressed, causing stupor, ending in unconsciousness; but this effect may be secondary to the disturbance of respiration. The cord is also lowered in activity. The peripheral *sensory nerves* are but little affected by the internal use of the drug, compared with its effect upon them locally. The *motor nerves* and *muscles* are depressed by repeated small doses of Diluted Hydrocyanic Acid, the influence extending downwards.

The chief specific use of this drug is to allay dry, useless cough, by its action on the respiratory centre and the afferent nerves, in phthisis, pertussis, and asthma. In phthisis it also checks the tendency to cough and vomit induced by food. As a cardiac sedative it is employed in the palpitation, pain, and distress brought on by dyspepsia, where again it fulfils a double indication. Its general sedative effect on the nervous system has suggested its use in epilepsy, chorea, hysteria, and tetanus, but with very doubtful benefit.

4. REMOTE LOCAL ACTION.

The mode of excretion of Hydrocyanic Acid is still obscure. Probably it escapes in part, as it enters in part, by the lungs; and some of it is supposed to be thrown out as formate of ammonium.

Trimethylamin.—(*Not official.*)

An ammonium compound, in which the three atoms of Hydrogen are replaced by Methyl, $NC_3H_9 = N(CH_3)_3$, dissolved in water.

Source.—Obtained from herring brine by distillation. It is also contained in cod-liver oil and in various plants.

Characters.—Contains 10 to 20 per cent. of the ammonium compound. Colourless, with a very disagreeable smell and taste; alkaline; miscible with water. *Dose*, 20 to 60 min.

ACTION AND USES.

Externally, Trimethylamin is a local stimulant. *Internally*, **it lowers the frequency of the heart, the blood pressure, and the temperature.** It was for a time believed to be specially valuable in acute rheumatism, but it is now very seldom used.

Acidum Carbolicum. — CARBOLIC ACID. PHENIC ACID, PHENOL, PHENYL ALCOHOL. C_6H_5HO.

An acid obtained from coal-tar oil by fractional distillation and subsequent purification.

Characters.—Acicular crystals, colourless or with a reddish tinge; hygroscopic; with a tarry odour and burning taste. Becomes and remains fluid on addition of 5 to 10 per cent. of water; melts at 91·5° Fahr. to an oily liquid. *Solubility*, 1 in 12 to 18 of water; 1 in 1¾ olive oil; freely in glycerine, chloroform, ether, and alcohol, and in volatile oils. Does not redden blue litmus paper. Coagulates albumen. Neutral solution of perchloride of iron strikes a deep purple colour, and bromine water gives a white precipitate, with a cold saturated aqueous solution. Solutions of Ammonia and of Chlorinated Soda produce a deep purple coloration. *Impurity.*—Aurin ($C_{19}H_{14}O_3$), or Rosolic Acid ($C_{20}H_{16}O_3$), which give the purplish-red colour to Carbolic Acid when exposed, by absorption of carbonic acid and oxygen.

Dose.—1 to 3 gr.

Preparations.

1. **Acidum Carbolicum Liquefactum.** — Carbolic Acid liquefied by the addition of 10 per cent. of Water.

Characters.—A colourless or very slightly reddish or brownish liquid; having the taste and odour of Carbolic Acid. Sp. gr. 1·064 to 1·067 at 60° Fahr. Dissolves 18 to 26 per cent. of water at 60° Fahr., yielding a nearly clear solution, from which any impurity separates as dark oily drops. *Dose*, 1 to 4 min.

2. **Glycerinum Acidi Carbolici.**—1 to 4 by measure.

3. **Suppositoria Acidi Carbolici cum Sapone.**—1 gr. in each, with Curd Soap and Glycerine of Starch.

4. **Unguentum Acidi Carbolici.**—1 to 18 of Soft and Hard Paraffin.

From Acidum Carbolicum are made:

Sodii Sulphocarbolas.—$NaC_6H_5SO_4,2H_2O$.

Source.—Made by (2) supersaturating with Carbonate of Barium a solution of (1) Carbolic Acid in an excess of Sulphuric Acid; (3) precipitating the filtrate with Carbonate of Sodium; and evaporating the filtrate. (1) $2H_2SO_4 + HC_6H_5O = HC_6H_5SO_4 + H_2O + H_2SO_4$. (2) $H_2SO_4 + 2HC_6H_5SO_4 + BaCO_3 = Ba(C_6H_5SO_4)_2 + H_2O + CO_2$. (3) $Ba(C_6H_5SO_4)_2 + Na_2CO_3 = 2NaC_6H_5SO_4 + BaCO_3$.

Characters. — Colourless transparent rhombic prisms, nearly inodorous, with cooling saline and bitter taste. Soluble in water, less so in spirit. H_2SO_4 sets free carbolic acid. *Dose*, 10 to 15 gr.

Zinci Sulphocarbolas. — $Zn(C_6H_5SO_4)_2,H_2O$.

Source.—Made by (1) heating a mixture of Carbolic and Sulphuric Acids; (2) saturating the product with Oxide of Zinc; evaporating, and crystallising. (1) $C_6H_5HO + H_2SO_4 = HC_6H_5SO_4 + H_2O$. (2) $2HC_6H_5SO_4 + ZnO = Zn2(C_6H_5SO_4) + H_2O$.

Characters. — Colourless transparent, tabular, efflorescent crystals; soluble in twice their weight of spirit or of water.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The principal action and uses of Carbolic Acid in disease depend upon its influence on fermentation and decomposition, which are intimately associated with many pathological processes. When this influence is studied apart from the body, we find that most *organised ferments* (yeasts, moulds, and bacteria) are readily deprived of their characteristic powers by solutions of Carbolic Acid; whilst *chemical* *ferments* (*enzymes*), such as pepsin and ptyalin, are much less readily affected. Although its effect on the *spores* of vegetable organisms is but small, a 5 per cent. solution being required to destroy them, its effect on fully developed microzymes is very great, a 1 per cent. *aqueous* solution certainly destroying the anthrax bacillus, and 1 part in 1000 being sufficient to prevent its growth. Carbolic Acid is thus an **antizymotic** (ἀντὶ, against, ζύμη, a ferment), and in the case of the zymosis of septic diseases, an **antiseptic.** At the same time the products of decomposition, which are generally infective and foul smelling, are destroyed by the Carbolic Acid, which is therefore said to be **disinfectant and deodorant.** The exact *modus operandi* of the Phenol is still obscure, as are also the nature of the fermentative processes, and the relation of organisms to them. Be the explanation what it may, the power of Carbolic Acid, or of any substance which can thus arrest molecular processes universally at work in physiology and pathology, must be regarded as enormous, both in itself and in its effects.

Carbolic Acid is extensively employed in the **antiseptic** method of the treatment of wounds, associated with the name of its introducer, Sir Joseph Lister. A 5 per cent. solution in water serves as a spray, to cleanse instruments, and to wash the skin of the part before operation. A 2½ per cent. watery solution is used to purify sponges and the hands of the operator, and as a lotion. Dissolved in olive oil 1 to 10, 1 to 20, 1 to 50 (or still weaker), or 1 part of Carbolic Acid with 7 parts of Castor Oil and 8 of Almond Oil, it is used for lubricating catheters, or as a special dressing; but the value of these oily compounds is very doubtful, as they have been found to have no influence on germs. Carbolic Acid Gauze consists of unbleached cotton gauze medicated with half its weight of a mixture of Carbolic Acid (1), Resin (4), and Paraffin (4). Liquefied Carbolic Acid is a convenient form for general use. Sulphocarbolate of Zinc is also used as a disinfectant and antiseptic.

Coming to its physiological action proper on the human tissues, we find that Carbolic Acid is a local irritant to the skin, causing a momentary sense of burning followed by anæsthesia, and finally a caustic effect with formation of a hard white eschar. It may therefore be applied to poisoned wounds and foul ulcers; and in dilute solutions (1 to 40) is a **stimulating** as well as a disinfecting wash to wounds and discharging mucous surfaces or cavities, in the form of a lotion, injection, or gargle. It also relieves itching, especially in cases where a strong solution (1 in 20) can be applied, *i.e.* where the skin is not inflamed. It is used with success in ringworm, where it destroys the vegetable organisms.

Apart from the body, Carbolic Acid is extensively used as a **general disinfectant**, to disinfect stools, flush drains, etc.

Internally.—In the form of vapour, Carbolic Acid is stimulant and disinfectant, and is used in ulceration of the throat and lungs (phthisis, dilated bronchi, gangrene, etc.), much importance having lately been attached to it in the so-called "antiseptic" treatment of phthisis. In the stomach and bowels it is a powerful irritant poison in large doses; in moderate quantity, or as the Sulphocarbolates, it arrests fermentative changes in the gastric contents in cases of dilatation of the viscus. Two other points may be noted in this connection; first, that Carbolic Acid unites with sulphates to form sulphocarbolates, which suggests the use of soluble sulphates as antidotes in poisoning by the drug; and secondly, that Phenol is a natural product of the action of the pancreatic ferment on proteids.

2. ACTION IN THE BLOOD.

Carbolic Acid is rapidly absorbed from the unbroken skin, mucosæ, wounds, subcutaneous tissues, respiratory passages, and stomach; and for a considerable time can be found in the blood unchanged. Here it steadily disappears, by conversion into compounds from which it may be again derived: uniting, for example, with sulphates, as already described. The blood is dark, and slow to coagulate, after poisoning by the drug.

3. SPECIFIC ACTION AND USES.

The action of Carbolic Acid on the organs is of little interest to the therapeutist. It is found in them chiefly as phenol-yielding compounds; and its effects in man are chiefly those of an irritant poison. The heart first falls and then rises in frequency, from disturbance of the cardiac centre. The blood pressure rises at first, returns to the normal, and falls after a fatal dose. Dyspnœa ensues, also central in origin. Convulsions occur in the lower animals through the cord, then paralysis and collapse. The voluntary muscles are not affected by Carbolic Acid, but the pupil is contracted. Sensibility is not reduced by internal administration of the drug. The temperature falls slightly after medicinal doses, but may rise in cases of dangerous absorption from dressings. Carbolic Acid and the Sulphocarbolates have been given internally in fevers, but are little used in this country for such a purpose. Carbolic Acid may temporarily relieve diabetes.

4. REMOTE LOCAL ACTION.

Carbolic Acid and its products rapidly leave the body, chiefly by the urine. But little of it can be recovered unchanged, for (1) part is lost in the system, being probably converted into oxalates and carbonates; (2) part appears as sulphocarbolic acid ($C_6H_5HSO_4$) in combination; (3) part is constituted by an obscure compound; and (4) the remainder appears to give rise to a peculiar olive-green, brown, or grey discoloration of the urine (probably due to a compound of hydrochinon, $C_6H_4(HO)_2$, which is familiar to surgeons. It is important to note that this change in the urine bears no definite relation to the amount of Carbolic Acid in the blood, nor the danger of poisoning. Fainting and collapse are the principal symptoms of its excessive absorption from a wound or through the skin, with or without rise of temperature. Disappearance of the sulphates from the urine, easily ascertained by ordinary tests, is a sure indication of danger. Albuminuria is sometimes induced.

Carbolic Acid also leaves the body by the saliva, which is increased; and it stimulates the flow of sweat, although it is not found in it.

Resorcin.—(*Not official.*) $C_6H_4(HO)_2$. — A derivative of Carbolic Acid by various processes.

Characters.—White tabular lustrous crystals, with a weak odour like Carbolic Acid, and a sweetish, somewhat pungent, taste. *Solubility*, 1 in 2 of water; 1 in 20 of olive oil.

Dose.—5 to 30 gr. every two hours, or single doses of 60 gr. at long intervals.

ACTION AND USES.

Externally.—Resorcin is **antiseptic and disinfectant** without being irritant in ordinary solutions (2 to 10 per cent.) It has been used as a dressing for all kinds of sores and wounds.

Internally.—It passes rapidly through the system, and is excreted unchanged in the urine by the end of one hour. It causes profuse diaphoresis, and **reduces the temperature and pulse** for a time, in conditions of fever; but has no obvious influence on the normal body-heat. Excessive doses cause trembling, singing in the ears, deafness, and mental disturbance. It has been used as an **antipyretic** in fevers of every kind, and is said to be specially useful in ague; but the drug has not proved itself a convenient remedy, as doses sufficiently large to be antipyretic produce debilitating sweats and serious nervous disturbance, whilst the temperature, though quickly lowered, may as quickly rise again.

Hydrochinon.—(*Not official.*) $C_6H_4(HO)_2$. A derivative of coal-tar. May also be made from Quinic Acid. (See *Cinchona.*) In crystals; inodorous, sweetish, neutral, soluble in water.

Dose.—10 to 15 gr.

ACTION AND USES.

Hydrochinon is an **antiseptic and disinfectant** externally; an **antipyretic** internally, closely resembling Resorcin, with which it is isomeric.

Chinolin.—(*Not official.*) C_9H_7N. A derivative of Cinchona Bark, whence its name. Now made synthetically, or by the action of Glycerine on Nitrobenzol and Aniline, in the presence of a dehydrating agent.

Characters. — A colourless, oily-like, highly refracting liquid, with a peculiar odour. It forms salts with acids, of which the Tartrate is used, occurring in lustrous needles, soluble in water. *Dose,* of Chinolin, 3 to 10 min.; of the Tartrate, 5 to 15 gr.

ACTION AND USES.

Externally, Chinolin is **antiseptic and disinfectant.** *Internally,* it is an **antipyretic** like Resorcin, and has been used for the same class of cases.

Antipyrine. (*Not official.*)—DIMETHYL OXY-CHINICIN. $C_{11}H_{12}N_2O$. An alkaloid prepared from Chinolin.

Characters.—A white crystalline powder, with a sweetish-bitter, rather pleasant, taste. Very soluble in water.

Dose.—5 to 20 gr. every hour in acute cases, until 60 to 75 gr. have been taken per diem. 5 to 15 gr. every four to eight hours in chronic cases.

ACTION AND USES.

Antipyrine appears to be the most powerful and useful of the new **antipyretics.** Its action resembles that of Resorcin and Kairin in quickly reducing the temperature in fever, the defervescence beginning within the first hour; but it is more persistent, and seldom attended by the unpleasant effects of the other drugs. It decidedly controls the pyrexia, and relieves the general symptoms, of most of the acute specific diseases, phthisis, and sunstroke, both in adults and children; it is less useful in ague and rheumatism. Free perspiration and occasional sickness and eruptions may attend the use of Antipyrine; and fatal collapse has occurred in at least one case. If it disagree with the stomach, it may be given either subcutaneously as a 5 per cent. solution, or by the rectum.

Kairin. (*Not official.*)—HYDROCHLORATE OF OXY-ETHYL-CHINOLIN HYDRID. White crystals, with a nauseous bitter taste; soluble in water. Made from Phenol. *Dose*, 5 gr. every hour; or 15 to 20 gr. in single doses.

Thalline. (*Not official.*) — TETRAHYDRO-PARA-METHYL-OXY-CHINOLIN. An alkaloid made from Chinolin. Whitish crystals, with an odour and taste like meadow-sweet; soluble in water. The Sulphate is chiefly used; *dose*, 2 to 8 gr.

ACTION AND USES.

Kairin and Thalline are **antiseptic, disinfectant,** and **antipyretic,** like the preceding substances, to which they are certainly inferior. Kairin should be given in pill.

Fuchsin. (*Not official.*) — HYDROCHLORATE OF ROSANILIN. $C_{20}H_{10}N_3,HCl$. Brilliant beetle-coloured needles, forming an intense deep-red solution with water. *Dose*, $\frac{1}{2}$ to 4 gr. in pill.

ACTION AND USES.

Fuchsin has been said to reduce the amount of albumen in some cases of Bright's disease.

Naphthalin. (*Not official.*)—$C_{10}H_8$.

Naphthol. (*Not official.*) — (β-NAPHTHOL; ISO-NAPHTHOL.) $C_{10}H_7HO$. Products of the distillation of Coal Gas.

Characters. — Naphthalin occurs in colourless shining plates, with an odour and taste of tar. It is perfectly insoluble in water; soluble in hot alcohol, ether, and benzol. Iso-Naphthol occurs in minute white shining plates, with a pleasant balsamic odour. It is sparingly soluble in hot water; soluble in alcohol, ether, olive oil, and excess of paraffin.

ACTION AND USES.

Naphthalin is a powerful **antiseptic and disinfectant**. It has been used chiefly as an external disinfectant, much like Iodoform, and has also been given internally, in doses of 2 to 8 gr., as an intestinal disinfectant in typhoid fever, diarrhœa, and dysentery. Its action on the contents of the bowel is purely local, most of the dose being recoverable from the fæces, whilst the traces which are absorbed are excreted also unchanged in the urine. β-Naphthol is applied, as ointment or solution (5 to 15 per cent.), in some diseases of the skin instead of Tar, which it closely resembles in its action.

Creasotum.—CREASOTE. A product of the distillation of Wood Tar.

Characters.—A liquid, colourless or with a yellowish tinge, a strong empyreumatic odour, and burning taste. *Solubility:* Sparingly in water; freely in alcohol, ether, and glacial acetic acid. Sp. gr. 1·071. *Impurity.*—Carbolic Acid; detected by becoming solidified on cooling. *Incompatible*, Oxide of Silver.

Composition.—Creasote is not a simple body, but a variable compound of *guaiacol* $C_7H_8O_2$, and *creasol* $C_8H_{10}O_2$.

Dose.—1 to 3 drops, with mucilage or bread crumb.

Preparations.

1. **Mistura Creasoti.**—Creasote, 1; Glacial Acetic Acid, 1; Spirit of Juniper, 2; Syrup, 32; Water, 480. *Dose*, 1 to 2 fl.oz.

2. **Unguentum Creasoti.**—1 in 9 of Simple Ointment.

3. **Vapor Creasoti.**—12 min. in 8 fl.oz. of Boiling Water.

ACTION AND USES.

The action of Creasote is, practically speaking, the same as that of Carbolic Acid, to which the student is referred. Before the latter came into general use, Creasote was not unfrequently employed for the same purposes internally to which Carbolic Acid is now put; but the uncertainty of its composition and strength, as a complex product, renders it inferior to Phenol in this respect.

The Unguentum is employed in dry skin diseases. The Vapor is **disinfectant and deodorant** in phthisis, chronic bronchitis, gangrene, and other diseases of the lungs attended by foul discharges. A combination of Creasote, Iodine, and various volatile substances such as Ether, Chloroform, and Spirit, has lately become popular as a constant inhalation in phthisis. The Mistura Creasoti is intended chiefly as a remedy in vomiting due to pyloric obstruction, dilatation of the stomach, and consequent fermentation. The special value of the drug in this class of cases depends on the fact that whilst it readily destroys low vegetable organisms, and arrests the fermentations with which they are associated, it does not interfere with the action of pepsin and the digestive process. It has also been recommended in the vomiting of pregnancy, hysteria, and sea-sickness; and in some forms of diarrhœa due to decomposition.

Iodoformum.—IODOFORM. CHI_3.

Source.—Made by heating Iodine with Carbonate of Potassium, Alcohol, and Water; and allowing the crystalline deposit to settle. $C_2H_6O + 4I_2 + 3K_2CO_3 = CHI_3 + KCHO_2 + 5KI + 2H_2O + 3CO_2$.

Characters.—Small, lemon-coloured, lustrous crystalline scales, with a powerful and persistent saffron-like odour, and an unpleasant sweetish taste. Slightly soluble in water and spirit; soluble freely in fixed and volatile oils, ether, and chloroform. It contains more than 90 per cent. of iodine.

Dose.—$\frac{1}{2}$ to 3 gr. or more.

Preparations.

1. **Suppositoria Iodoformi.** — 3 gr. in each with 12 gr. of Oil of Theobroma.

2. **Unguentum Iodoformi.**—1 to 9 of Benzoated Lard.

Iodoform Wool. (*Not official.*) Absorbent Cotton Wool, containing 10 per cent. of Iodoform.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Iodoform is an **antiseptic and disinfectant**, but destroys organisms less readily than Carbolic Acid. It is a very powerful deodorant. Applied to the human tissues, it produces little or no irritation.

Iodoform is used to cleanse foul ulcers, especially of venereal origin; and may possibly have a special effect on strumous ulceration. It has also been extensively applied as an antiseptic dressing to healing wounds, the best forms being the Wool and the Ointment. Sometimes Iodoform Gauze has been employed. Iodoform bougies for insertion into the urethra and os uteri have not given satisfaction. A powder of Iodoform diluted with Quinine or Bismuth is a valuable insufflation in ozæna and ulcers of the mouth and throat.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Iodoform is occasionally absorbed from wounds, causing sickness and fever, restlessness and delirium in some subjects, drowsiness and collapse in others. Iodine is possibly set free in the blood or tissues, and appears in the urine in part as iodide of sodium. Iodoform has been used in an endless variety of diseases internally, but unfortunately with no special benefit.

Paraffinum Durum.—Hard Paraffin. A mixture of several of the harder members of the Paraffin series of hydrocarbons. Usually obtained by distillation from shale; separation of the liquid oils by refrigeration; and purification of the solid product.

Characters.—Colourless, semitransparent, crystalline, inodorous and tasteless, slightly greasy to the touch. Sp. gr. 0·82 to 0·94. *Solubility:* Slightly in absolute alcohol, freely in ether and chloroform; insoluble in water. Melts at 110° to 145° Fahr.

Paraffinum Durum is contained in many Ointments.

Paraffinum Molle.—Soft Paraffin. "Vaselin." A semisolid mixture of the softer or more fluid members of the paraffin series of hydrocarbons;

usually obtained by purifying the less volatile portions of petroleum.

Characters.—White or yellowish, translucent, soft, greasy; free from acidity, alkalinity, or any unpleasant odour or flavour. Sp. gr. 0·840 to 0·870. Melts at 95° to 105° Fahr. Insoluble in water. Is not saponified by solutions of alkalies.

Paraffinum Molle is contained in many Ointments.

ACTION AND USES.

Paraffin cannot become rancid or irritant to the skin, and being readily miscible with many active substances, is indicated instead of Lard as a valuable **basis for ointments** intended to produce a *local* effect, especially those of Lead and Zinc. As it appears not to be absorbed by the skin, like fats, it is unfitted as a basis for applications intended to enter the system and produce their specific action, such as mercurials and alkaloids. Another disadvantage is the low point at which it melts, and its consequent tendency to spread through the dressings. It is now extensively used.

Part II.

THE ORGANIC MATERIA MEDICA.

GROUP I.

THE VEGETABLE KINGDOM.

RANUNCULACEÆ.

Aconiti Folia.—Aconite Leaves. The fresh leaves and flowering tops of Aconitum Napellus, gathered when about one-third of the flowers are expanded, from plants cultivated in Britain.

Characters.—Leaves alternate with long channelled stalks, very deeply cut palmately into five or three segments, which are again deeply and irregularly divided into oblong acute narrow lobes; exciting slowly, when chewed, a sensation of tingling and numbness. Flowers large, irregular, deep blue, in a somewhat loose terminal raceme.

Aconiti Radix.—Aconite Root. The dried root of Aconitum Napellus, collected in the winter or early spring before the leaves have appeared. Imported from Germany, or cultivated in Britain.

Characters.—Usually from 2 to 3 inches long, ½ to ¾ inch thick at the crown; conical; presenting scars or bases of broken rootlets; brown externally, whitish within. Cautiously chewed, causes tingling and prolonged numbness.

Composition.—The active constituent of Aconite is *aconitine* (probably $C_{33}H_{43}NO_{12}$), a white amorphous or crystalline alkaloid; *solubility*, 1 in 150 of cold, 1 in 50 of boiling water, much more readily in alcohol and ether. Causes tingling and prolonged numbness of the skin. *Pseud-aconitin, napellin, nepallin, napalin, aconellin*, are other more or less identical principles. They are combined with a peculiar acid, *aconitic acid.*

Preparations.

A. *Of the leaves and flowering tops:*

Extractum Aconiti.—A *green* extract. *Dose*, ¼ to 1 gr.

B. *Of the root:*

1. **Tinctura Aconiti.**—1 in 8 of Spirit. *Dose*, 5 to 15 min.
2. **Linimentum Aconiti.**—1 in 1½ of Spirit, with $\frac{1}{20}$ of Camphor.

From Aconiti Radix is made:

3. **Aconitina.** — An alkaloid obtained from Aconite Root. Made by (1) dissolving an alcoholic extract of the powdered root in water; (2) precipitating the impure aconitine by Ammonia; (3) extracting the dried precipitate with Ether; drying; dissolving in Sulphuric Acid and Water; precipitating with Ammonia, and purifying.

Characters.—See *Composition.* Not given internally.

Preparation.

UNGUENTUM ACONITINÆ.—1, dissolved in Spirit, to 55 of Benzoated Lard.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES

Externally.—Applied to the skin, or an exposed mucous membrane, Aconite affects the terminations of the sensory nerves, causing tingling, followed by numbness, and lowering the sensibility of touch and temperature. It is, therefore, used to relieve pain due to disorder of the peripheral nerves, especially certain forms of neuralgia, and acute and chronic rheumatism. The Aconitine Ointment must be employed with caution, especially in the neighbourhood of the eye.

Internally.—Aconite and Aconitine cause an intensely acrid sensation on the tongue, followed by persistent tingling and numbness. A sense of warmth and pain, and sickness follow its admission to the stomach in full doses.

2. ACTION IN THE BLOOD; SPECIFIC ACTION AND USES.

Aconitine enters the blood, and thence finds its way to the tissues. Medicinal doses of Aconite, taken in close succession, **reduce the frequency, force, and tension of the pulse; flush and moisten the skin; and increase the amount of urine.** Larger doses cause a sense of illness and muscular weakness; "creeping," "tingling," "numb" sensations generally, but especially in the lips, face, and extremities, ending in anæsthesia; and disturbances of vision, hearing, and consciousness. On analysis, it is found that the heart is briefly accelerated, and then reduced in frequency, through the nerves; its force is then reduced, by direct action on the nervo-muscular structures; and finally the cardiac action becomes very frequent, irregular, and more and more feeble, tending to cease in diastole. The blood pressure falls continuously, partly from cardiac, partly from vaso-motor depression. Respiration is slowed and deepened, with spasmodic irregularity of rhythm, and is finally arrested after poisonous quantities. The skin is stimulated, perspiration becoming abundant. The kidneys are also stimulated, both the fluids and solids of the urine being increased in amount. **The temperature falls steadily.** The muscular weakness appears to be primarily due to depression of the motor nerve endings; but this condition extends to the cord. The brain itself is not directly affected; and even in cases of poisoning by Aconite, consciousness, although disturbed, is preserved almost to the end. The sensory nerves are probably paralysed from their periphery inwards by the internal, as by the external, administration of the drug.

Such being the specific action of Aconite, its use is obviously indicated in the treatment of two conditions, namely, **fever** and **pain.** The cardio-vascular excitement, the dry skin, the high temperature and the scanty secretions of fever, will all be relieved by this drug. For this purpose the Tincture is given in small and closely repeated doses, say 1 minim in water every 15, 20, or 30 minutes, the effect being watched. Acute tonsillitis, bronchitis, pleurisy, and febrile conditions attending other local inflammations, have been treated with Aconite, the effect being to control the urgent symptoms, relieve the distress of the patient, and even to cut short the disease. Some of the symptoms of scarlatina and measles may be similarly alleviated. The powerfully depressant action of Aconite on the circulation entirely forbids its use as an antipyretic in heart disease, and suggests caution in its employment in all cases.

In neuralgia and other painful affections connected with the nerves and muscles, Aconite may be given internally instead of being locally applied; facial neuralgia with spasm (*tic-douloureux*) particularly being relieved by it. In these cases, also, the Tincture should be given in minim doses, repeated three or four times in an hour, and the effect watched.

3. REMOTE LOCAL ACTION AND USES.

Aconite is probably excreted by the kidneys, and, as we have seen, increases the activity of their secretion. The stimulation of the sweat glands, and the occasional appearance of an eruption, suggest that it also leaves the body by the skin.

Podophylli Rhizoma.—PODOPHYLLUM RHIZOME. The dried rhizome and rootlets of Podophyllum peltatum, American May-Apple. Imported from North America.

Characters.—In pieces of variable length, and from about $\frac{1}{5}$ to $\frac{1}{3}$ of an inch thick, flattened-cylindrical, presenting at intervals irregular tuberosities which are marked above by a depressed circular scar, and giving off below a number of very brittle brownish rootlets, or presenting a corresponding number of whitish scars; dark reddish-brown externally, smooth or wrinkled; fracture short; internally whitish and mealy. Odour faintly narcotic; taste bitterish, acrid, and nauseous.

Composition.—Podophyllum contains a *resin*, from which is obtained *podophyllotoxin*, a resinous body, composed of *picropodophyllic acid*, inert, and *picropodophyllin*, a crystalline neutral body, the active principle.

From Podophylli Rhizoma is obtained:

Podophylli Resina.—Resin of Podophyllin.

Source.—Made by extracting with Rectified Spirit; precipitating the resulting tincture in Water; washing, and drying.

Characters.—A pale yellow to deep orange-brown amorphous powder; soluble in rectified spirit, slowly in ammonia; precipitated from spirit by water; from ammonia by acids. *Dose*, $\frac{1}{4}$ to 1 gr.

Preparation.

Tinctura Podophylli. — 1 gr. in 1 fl.dr. of Rectified Spirit. *Dose*, 15 min. to 1 fl.dr.

ACTION AND USES.

Externally, Podophyllin possesses no local action; but if applied to a wound, it enters the blood, and exerts its specific effect as a purgative, to be presently described.

Internally, Podophyllin gives rise to a bitter acrid taste; possibly salivation, irritation of the stomach, nausea, and colic; and after ten or twelve hours produces a free watery motion. The **purgative** effect appears to be due to stimulation both of the muscular coat and the glands of the intestine, as well as to **increase of the biliary flow**.

Podophyllin is used entirely as a purgative. One-grain doses are given to produce free evacuation of the bowels in severe constipation or portal congestion. A dose of $\frac{1}{6}$ to $\frac{1}{4}$ grain may be employed as an ingredient of habitual laxative pills. It is a useful **cholagogue** when mercurials are contra-indicated. Podophyllin must not be given alone, on account of its griping tendency, but combined with a carminative, such as Hyoscyamus, Belladonna, or Cannabis Indica. The comparative slowness of its action must also be remembered.

Staphisagriæ Semina.—STAVESACRE SEEDS. The dried ripe seeds of Delphinium Staphisagria.

Characters.—Irregularly triangular or obscurely quadrangular, arched, blackish-brown when fresh, but becoming dull greyish-brown by keeping. Testa wrinkled and deeply pitted; nucleus soft, whitish, oily. No marked odour; taste nauseously bitter and acrid.

Composition.—Stavesacre contains four alkaloids, *delphinine*, allied to aconitine; *staphisagrine*, *delphinoidine*, and *delphisine*.

Preparation.

Unguentum Staphisagriæ.—1, crushed; macerated in 2 of melted Benzoated Lard.

ACTION AND USES.

Delphinine closely resembles Aconitine in its action, but is even more depressant to the vessels. Stavesacre is used only as a **parasiticide**, to kill pediculi.

Cimicifugæ Rhizoma.—CIMICIFUGA. The dried rhizome and rootlets of Cimicifuga racemosa (Actæa racemosa), Black Snake-root. The United States.

Characters.—Rhizome from 2 to 6 inches long, $\frac{1}{2}$ to 1 inch thick; hard, flattened-cylindrical, having on its upper surface the remains of aërial stems, and below numerous wiry brittle-branched rootlets, more or less broken off; colour brownish-black; almost odourless, and of a bitter acrid taste.

Composition.—Cimicifuga contains a *volatile oil*, two *resins*, and *tannin*. The active principle is uncertain. *Dose*, 20 to 30 gr.

Preparations.

1. **Extractum Cimicifugæ Liquidum.**—1 in 1 of Rectified Spirit. *Dose*, 3 to 30 min.
2. **Tinctura Cimicifugæ.**—1 in 8 of *Proof* Spirit. *Dose*, 15 to 60 min.

ACTION AND USES.

In moderate doses Black Snake-root is **bitter**; in larger doses it slows the heart and raises the blood pressure, like Digitalis; finally it is excreted in the urine, and increases the activity of the skin, kidneys, and generative organs.

Cimicifuga may be used as a **stomachic** in diseases of the heart; and in neuralgia, rheumatism, bronchitis, uterine disorders, and spermatorrhœa, in which its remote stimulant action is occasionally valuable. It has been much lauded in chorea.

Adonis Vernalis.—(*Not official.*) The root of Adonis vernalis. From Middle Europe.

Characters and Composition.—A dark brown, fibrous, branched root, containing an amorphous glucoside, *adonidin*.

ACTION AND USES.

Adonidin is closely allied in its action to digitoxin, one of the principles of Digitalis, but is more powerful, and even more irritating to the digestive organs. An Infusion ($\frac{1}{2}$ to 2 dr. to 6 fl.oz. of Water) has been given with success, as a cardiac stimulant and diuretic in heart disease and dropsy where the Foxglove has failed, in doses of $\frac{1}{2}$ fl.oz.

MAGNOLIACEÆ.

Anisi Stellati Fructus.—Star-Anise Fruit. The dried fruit of Illicium anisatum. From plants cultivated in China.

Characters.—Eight carpels diverging horizontally in a stellate manner from an axis; each carpel boat-shaped, beaked, irregularly wrinkled, rusty-brown, with a solitary reddish-brown seed. Odour and taste like those of Anise.

From Anisi Stellati Fructus is made:

Oleum Anisi.—*See* page 285.

MENISPERMACEÆ.

Calumbæ Radix.—Calumba Root. The dried transversely cut slices of the root of Jateorhiza Calumba. From the forests of eastern Africa, between Ibo and the Zambesi.

Characters.—Slices flattish, circular or oval, about 2 inches in diameter, and from 2 to 6 lines thick. Cortical part thick, with a wrinkled brownish-yellow coat; centre softer, thinner, and greyish-yellow; a fine dark line separating the two parts. Odour musty, taste bitter; friable, fracture mealy.

Composition.—Calumba contains a neutral bitter principle, *calumbin*, $C_{21}H_{22}O_7$, crystallising in white needles; a bitter alkaloid, *berberine*, $C_{20}H_{17}NO_4$, in yellow prisms, whence the colour of the root; *calumbic acid*, $C_{21}H_{21}O_7$; 33 per cent. of *starch;* but no tannin. *Dose*, 5 to 20 gr.

Preparations.

1. **Extractum Calumbæ.**—Spirituous. 8 in 1. *Dose*, 2 to 10 gr.
2. **Infusum Calumbæ.**—1 in 20 of *cold* Water. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Calumbæ.**—1 in 8 of *Proof* Spirit. *Dose*, ½ to 2 fl.dr.
4. *Calumba is also an ingredient of* Mistura Ferri Aromatica.

ACTION AND USES.

Calumba is the first of the large and important group of bitter substances or **bitters** which we meet with in the materia medica, and will therefore be fully discussed as the type of this class of remedies. Under the head of the other bitters, such as Quassia and Gentian, fresh description of their action and uses will be unnecessary, and reference will simply be made to the present account. So with the action and uses, *as bitters*, of the alkaloids (Strychnine, Quinine, etc.), and of the *aromatic bitters*, including Orange, Lemon, Cascarilla, etc.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Calumba and other bitters are antiseptic and disinfectant to a degree, arresting decomposition and fermentation. They are not used for this purpose.

Internally.—Taken into the mouth, bitters, as their name implies, stimulate the nerves of taste, and therewith induce several reflex effects, of the first importance in digestion. (1) The *saliva* is increased, and thus its solvent and digestive influence on the food in the mouth, as well as its stimulant action on the gastric secretion. (2) The *vessels and glands of the stomach* are excited through the central nervous system, and the gastric secretion is thus increased in a second way, an effect which is heightened if the bitter be aromatic, and relish given by the pleasant flavour.

Reaching the stomach, Calumba and other bitters stimulate digestion in a third way, by acting directly on the gastric nerves, causing a sensation closely resembling hunger. This rouses the appetite; and if food be taken within a few minutes, the other effects just described afford the means of digesting it. As in the mouth, the action of bitters in the stomach is greatly assisted by aromatics (essential oils) and alcohol (contained in tinctures). Like these substances, bitters also stimulate the local circulation, and produce a remote effect on the heart and systemic vessels, raising the blood pressure, and thus acting as "general tonics." They will also exert a certain controlling effect on any decomposition or fermentation which may be set up in the stomach. When given in excess, or for a long time, bitters will manifestly, for every reason, tend to irritate the stomach and induce indigestion.

Calumba and bitters in general pass slowly along the intestines, moderating decomposition, and slightly stimulating peristalsis unless they contain tannin, which many of them do. They are not cholagogue.

The *uses* of Calumba and other bitters internally depend on the actions just described. They are of great value as **stomachics**, and much employed in rousing gastric digestion in atonic dyspepsia, where the appetite and the ability to digest have been diminished or lost, as in anæmia, convalescence from acute diseases, in persons exhausted by over-work whether mental or bodily, and in the subjects of chronic constitutional diseases, such as phthisis and syphilis. In such cases, bitter infusions form the best vehicle for acid or alkaline stomachics, as the case may require, combined with an aromatic tincture which renders the mixture much more agreeable and active. Their use must not be continued too long without intermission; they must not be given in too concentrated a form; and they must be employed with caution, or entirely avoided, in cases of dyspepsia attended by much pain, vomiting, or mucous secretion, as well as in organic disease of the stomach. Calumba is one of the least irritant of all bitter stomachics.

The action of bitters on the bowels no doubt adds to their value in indigestion, as they remove flatulence and promote evacuation. Some forms of diarrhœa are relieved by Calumba. Whether given by the mouth or as an enema, bitter infusions are anthelmintic, preventing and destroying the threadworm.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

Whether bitters possess any *direct* action on the blood or tissues beyond those just described, is uncertain. Their *indirect* effect on the system is manifestly great, and of the first importance therapeutically, as they are the means of introducing into the blood an increased amount of nutrient material. In this way bitters are **tonics**, invigorating the body whilst they increase appetite; a system of treatment which is agreeable and striking to invalids and persons enfeebled by disease, over-work, or dyspepsia.

Pareiræ Radix.—PAREIRA ROOT. The dried root of Chondrodendron tomentosum.

Characters.—Long cylindrical twisted pieces, ¾ to 2 or more inches thick; with a thin blackish-brown bark, marked with longitudinal furrows and transverse ridges and fissures. Internally yellowish- or brownish-grey, with circles of porous wood, separated into wedge-shaped portions by large medullary rays; waxy when cut. No odour; taste bitter.

Composition.—Pareira Root contains a bitter alkaloid *pelosine*, $C_{18}H_{21}NO_3$, possibly identical with beberine; *starch*, and *resin*. *Incompatibles.*—Persalts of iron, salts of lead, and tincture of iodine.

Preparations.

1. **Decoctum Pareiræ.**—1 in 16. *Dose*, 1 to 2 fl.oz.
2. **Extractum Pareiræ.**—Aqueous. 16 in 1.* *Dose*, 10 to 30 gr.

From Extractum Pareiræ is prepared:

EXTRACTUM PAREIRÆ LIQUIDUM.—Extract dissolved in Spirit and Water. 1 in 4. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

The physiological action of Pareira is imperfectly known, but it is believed to possess mild **bitter** and **laxative** effects, and to be a moderately active **diuretic**.

Empirically, it is used in inflammatory affections of the urinary tract, from the pelvis of the kidney downwards, being held to relieve pain, reduce irritation, and promote healing and cessation of muco-purulent discharge. The Extract is given along with the Decoction to increase its strength; not alone.

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* That is, 16 parts of the crude drug are required to obtain 1 part of the preparation.

Cocculus Indicus.—(*Not official.*) The fruit of Anamirta paniculata. From the East Indies.

Characters.—A small dark brown berry, containing a yellowish reniform seed.

Composition.—The active principle of Cocculus is an odourless, very bitter, neutral substance, *picrotoxin*, $C_9H_{10}O_4$, in colourless crystals, soluble with difficulty in water. It is united with *menispermic* or *cocculinic acid*, and other principles.

Dose of Picrotoxin.—$\frac{1}{120}$ to $\frac{1}{25}$ gr.

Non-official Preparation.

UNGUENTUM COCCULI.—Seeds 80 gr., Lard 1 oz.

ACTION AND USES.

Externally, Cocculus or Picrotoxin, in the form of the Ointment, very carefully applied to the unbroken surface, **destroys pediculi.**

Internally, Picrotoxin is a very powerful agent, especially stimulating the motor centres and medulla, and causing violent **spasms of the flexors** and intoxication in large doses. It has been chiefly used in the **night-sweating of phthisis**, and in chronic nervous diseases.

PAPAVERACEÆ.

Papaveris Capsulæ.—POPPY CAPSULES. The *nearly ripe* dried capsules of Papaver somniferum, the White Poppy. Cultivated in Britain.

Characters.—Globular, 2 to 3 inches in diameter, crowned by stellately arranged stigmas. Yellowish-brown; frequently with blackish spots. Presents internally thin parietal placentas, and very many small reniform whitish or blackish seeds. Inodorous; slightly bitter.

Composition.—Poppy Capsules contain a little *opium* and woody fibre; the seeds, a bland oil. See *Opium.*

Preparations.

1. **Decoctum Papaveris.**—1 in 10. Not given internally.

2. **Extractum Papaveris.**—Aqueous and spirituous. 3 in 1. *Dose*, 2 to 5 gr.
3. **Syrupus Papaveris.**—1 in 3, nearly. *Dose*, 1 fl.dr.

ACTION AND USES.

The action of Poppy Capsules is the same as that of Opium, but much weaker. The warm Decoction is a favourite **anodyne** fomentation. The Extract and Syrup are uncertain remedies, and preparations of Opium are in every respect preferable.

Opium.—OPIUM. The juice obtained by incision from the *unripe* capsules of Papaver somniferum, the White Poppy. Inspissated by spontaneous evaporation. Grown in Asia Minor.

Characters. — Rounded, irregular, or flattened masses, weighing from 8 ounces to 2 pounds; generally covered with portions of poppy leaves, and scattered over with the chaffy fruits of a species of rumex. When fresh, plastic, moist, coarsely granular, and reddish- or chestnut-brown; but becoming harder by keeping, and darkening to blackish-brown. Odour strong, peculiar, narcotic; taste nauseously bitter.

Varieties.—There are two varieties of official Opium: (1) Opium from Asia Minor; and (2) any ordinary variety. (1) *Smyrna*, *Turkey*, or *Levant* Opium is the best. It occurs in irregular, rounded, or flattened masses, seldom more than two pounds in weight, enveloped in poppy leaves, and surrounded with the fruits or seeds of rumex. Good Smyrna Opium yields 10 to 12 per cent. of Morphine. (2) *a. Constantinople* Opium is generally inferior to Smyrna. It is found in cakes, either large and irregular, or small and lenticular, covered with a poppy leaf, and marked with its midrib, but without rumex seeds. It smells much less strongly than Smyrna Opium. *b. Egyptian* Opium occurs in round flattened cakes of a reddish hue, with vestiges of a leaf. *c. Persian* Opium is in sticks or lumps. *d. Indian* Opium is in balls enveloped in poppy leaves, or in cakes. *e.* There are also *French* and *English* varieties.

Composition.—Opium contains (1) certain *alkaloids;* (2) two *neutral substances;* (3) two organic *acids;* (4) about 16 per cent. of *water;* (5) resin, gum, salts, extractives, odorous principles, and other constituents of plants. *The important constituents* are as follows:

	Parts in 100 parts.	Constitution.	Reaction.	Characters.
1. Morphine	5 to 12	$C_{17}H_{19}NO_3$	Alkaline	White needles.
2. Codeine	up to ·6	$C_{18}H_{21}NO_3$	Alkaline	See page 213.
3. Thebaine or Paramorphine	up to ·3	$C_{19}H_{21}NO_3$	Alkaline	White plates, with acrid styptic taste.
4. Opianine ...	·5 to 1	—	—	—
5. Cryptopine		$C_{23}H_{25}NO_5$	Alkaline	—
6. Metamorphine		—	—	—
7. Papaverine		$C_{20}H_{21}NO_4$	Alkaline	White needles.
8. Narcotine	4 to 6	$C_{22}H_{23}NO_7$	Alkaline	Shining prisms; tasteless, odourless.
9. Narcein	up to ·02	$C_{23}H_{29}NO_9$	Neutral	Fine white needles; odourless, bitter.
10. Porphyroxin ...	—	—	—	—
11. Laudanin	—	$C_{20}H_{25}NO_4$	—	—
12. Meconin	·08 to ·3	$C_{10}H_{10}O_4$	Neutral	White needles; odourless, acrid.
13. Meconic Acid ...	4 to 8	$C_7H_4O_7$	Acid	See page 212.
14. Thebolactic Acid	—	Probably Lactic Acid	Acid	—

Impurities (chiefly adulterations).—Opium is often soft from excess of water, which causes a great variation in the strength. Stones, fruits, leaves, etc., may be detected by filtering a decoction; and starch by the iodine test. The official test is intended to ascertain the amount of Morphine in specimens which are pure but of doubtful richness. *Test.*—This is a modification of the process for making Hydrochlorate of Morphine. (*See* page 211.) 100 gr. dried at 212° ought to yield from 9½ to 10½ gr. of Morphine.

General chemical characters, reactions, and incompatibilities of Opium.—A fluid (watery or spirituous) preparation of Opium reddens litmus paper (free meconic acid). It gives a deep red colour with perchloride of iron (meconic acid); precipitates with acetate and subacetate of lead, nitrate of silver, zinc, copper, and arsenic (meconates, sulphates, and colouring matter); a precipitate with tincture of galls or astringent preparations (tannate of codeine). It becomes turbid with fixed alkalies and their carbonates, alkaline earths, and ammonia (precipitated morphine and narcotine).

Dose of Opium.—½ to 3 gr.

Preparations.

1. **Emplastrum Opii.**—1 in 10, with Resin Plaster.
2. **Extractum Opii.**—Aqueous. 2 in 1. *Dose*, ½ to 1 gr.

From Extractum Opii are prepared:

a. EXTRACTUM OPII LIQUIDUM.—1 of Extract macerated in 16 of Water, with 4 of Spirit added. 1 of Opium (*i.e.* ½ of Extract) in 10. *Dose*, 10 to 40 min.

b. TROCHISCI OPII.—$\frac{1}{10}$ gr. of Extract (*i.e.* $\frac{1}{5}$ gr. of Opium) in each. *Dose*, 1 to 2.

c. VINUM OPII.—½ of Extract (*i.e.* 1 of Opium) in 10 of Sherry, with Cinnamon and Cloves. 22 min. = 1 gr. of Extract. *Dose*, 10 to 40 min.

3. **Pilula Plumbi cum Opio.**—Opium, 1; Acetate of Lead, 6; Confection of Roses, 1. 1 in 8. *Dose*, 4 to 8 gr.
4. **Pilula Saponis Composita.**—Opium, 1; Hard Soap, 4; Water, *q.s.* 1 in 6, nearly. *Dose*, 3 to 5 gr.
5. **Pulvis Opii Compositus.**—Opium, 3; Black Pepper, 4; Ginger, 10; Caraway, 12; Tragacanth, 1. 1 in 10. *Dose*, 2 to 5 gr.

From Pulvis Opii Compositus is prepared:

CONFECTIO OPII.—Compound Powder, 1; Syrup, 3. 1 of Opium in 40. *Dose*, 5 to 20 gr.

6. **Pulvis Ipecacuanhæ Compositus.**—Dover's Powder. Opium, 1; Ipecacuanha, 1; Sulphate of Potassium, 8. 1 in 10. *Dose*, 5 to 15 gr.

From Dover's Powder is prepared:

PILULA IPECACUANHÆ CUM SCILLÂ.—Compound Ipecacuanha Powder, 3; Squill, 1; Ammoniacum, 1; Treacle, *q.s.* 1 of Opium in 23. *Dose*, 5 to 10 gr.

7. **Pulvis Kino Compositus.**—Opium, 1; Kino, 15; Cinnamon, 4. 1 in 20. *Dose*, 5 to 20 gr.
8. **Pulvis Cretæ Aromaticus cum Opio.**—Opium, 1; Aromatic Chalk Powder, 39. 1 in 40. *Dose*, 10 to 40 gr.
9. **Suppositoria Plumbi Composita.**—Opium, 1 gr.; Acetate of Lead, 3 gr.; and Oil of Theobroma, 11 gr. 1 gr. of Opium in each Suppository.
10. **Tinctura Opii.**—"Laudanum." Opium, 1⅓; Proof Spirit, 20. 1 gr. in 14½ min. 25 min. = 22 min. of Extractum Opii Liquidum or Vinum Opii. *Dose*, 5 to 40 min.

From Tinctura Opii are prepared:

a. ENEMA OPII.—Tincture of Opium, ½ fl.dr.; Mucilage of Starch, 2 oz. For one enema.

b. LINIMENTUM OPII.—Equal parts of Tincture of Opium and Soap Liniment.

11. **Tinctura Opii Ammoniata.**—"Scotch Paregoric." Opium, 100 gr.; Saffron, 180 gr.; Benzoic Acid, 180 gr.; Oil of Anise, 1 fl.dr.; Strong Solution of Ammonia, 4 fl.oz.; Rectified Spirit, 16 fl.oz. 1 in 96. *Dose*, 30 to 60 min.
12. **Tinctura Camphoræ Composita.**—"Paregoric." Opium, 40 gr.; Benzoic Acid, 40 gr.; Camphor, 30 gr.; Oil of Anise, ½ fl.dr.; Proof Spirit, 20 fl.oz. 1 in 240. *Dose*, 15 to 60 min.
13. **Unguentum Gallæ cum Opio.**—Opium, 32 gr.; Ointment of Galls, 1 oz. 1 in 14⅔.

From Opium are made:

14. **Morphinæ Hydrochloras.** — Hydrochlorate of Morphine. $C_{17}H_{19}NO_3,HCl,3H_2O$.

Source.—Made by (1) precipitating and rejecting the meconic acid and resins, by adding a solution of Chloride of Calcium to a concentrated cold watery infusion of Opium; (2) evaporating the solution (containing hydrochlorates of the alkaloids) until it becomes solid on cooling, pressing the mass to remove colouring matter, exhausting with boiling water, filtering, evaporating, and pressing again; (3) repeating process (2) until solution is nearly colourless; completing decolorisation by digesting a solution of the solid mass in boiling water with charcoal, and filtering; (4) precipitating morphine by ammonia, washing, diffusing in water; (5) dissolving in Hydrochloric Acid, and crystallising out.

Characters.—White acicular prisms of silky lustre. *Solubility:* 1 in 24 of water; readily in spirit. Solutions yield a white precipitate with KHO, soluble in excess. Morphine salts give an orange-red colour when moistened with HNO_3; a greenish-blue with neutral solution of Fe_2Cl_6. *Incompatibles.* — The alkaline carbonates, lime-water, salts of lead, iron, copper, mercury, and zinc, Liquor Arsenicalis, and all astringent vegetable preparations. *Dose*, ⅛ to ½ gr.

Preparations.

a. **Liquor Morphinæ Hydrochloratis.**—Solution of Hydrochlorate of Morphine. 4½ gr. in 1 fl.oz. of a mixture of Spirit, Water, and Diluted Hydrochloric Acid. 1 in 100. *Dose*, 10 to 50 min.

b. **Suppositoria Morphinæ.**—½ gr. in each, with 14½ gr. of Oil of Theobroma.

c. **Suppositoria Morphinæ cum Sapone.**—½ gr. in each, with Glycerine of Starch, Curd Soap, and Starch.

d. **Tinctura Chloroformi et Morphinæ.**—$\frac{1}{48}$ gr. in 10 min. *See* page 161.

e. **Trochisci Morphinæ.**—$\frac{1}{36}$ gr. of Hydrochlorate of Morphine in each. *Dose,* 1 to 6.

f. **Trochisci Morphinæ et Ipecacuanhæ.** — $\frac{1}{36}$ gr. of Hydrochlorate of Morphine and $\frac{1}{12}$ gr. of Ipecacuanha in each. *Dose,* 1 to 6.

From Morphinæ Hydrochloras is made:

g. **Morphinæ Acetas.** — Acetate of Morphine. $C_{17}H_{19}NO_3,HC_2H_3O_2,3H_2O$.

Source.—Made by precipitating Morphine from a watery solution of the Hydrochlorate by means of ammonia; dissolving in Acetic Acid and Water; and evaporating.

Characters.—A white powder. *Solubility.*—1 in 2½ of water; readily in spirit. *Dose,* ⅛ to ½ gr.

Preparations.

α. **Injectio Morphinæ Hypodermica.** — Hypodermic Injection of Morphine. Made by freshly preparing the Acetate as above, but without evaporating. 1 gr. of Acetate in 10 min. *Dose,* hypodermically, 1 to 3 min.; or more with care.

β. **Liquor Morphinæ Acetatis.**—Solution of Acetate of Morphine. 4½ gr. in 1 fl.oz. of a mixture of Spirit, Water, and Diluted Acetic Acid. 1 in 100. *Dose,* 10 to 50 min.

15. **Morphinæ Sulphas.**—$(C_{17}H_{19}NO_3)_2,H_2SO_4,5H_2O$.

Source.—Made like the Hydrochlorate, Sulphuric Acid being used to dissolve the pure Morphine in stage (5). About 1 of Sulphate is obtained from 7½ of Opium.

Characters.—Colourless silky needles. *Solubility.*—1 in 24 of water; sparingly in spirit. *Dose,* ⅛ to ½ gr.

16. **Acidum Meconicum.**—Meconic Acid. $H_3C_7HO_7$.

Source.—Made by adding Chloride of Calcium to a concentrated infusion of Opium nearly neutralised with Ammonia; washing the precipitated meconate of calcium; placing it in hot water; and adding Hydrochloric Acid. The clear liquid on cooling deposits Meconic Acid.

Characters.—Nearly colourless micaceous crystals. Sparingly soluble in water; readily soluble in alcohol, yielding a solution having a strong acid taste and reaction, and coloured red by neutral solution of perchloride of iron, the colour being discharged by strong, but not by diluted, hydrochloric acid.

Preparation.

Liquor Morphinæ Bimeconatis.—Made by precipitating Morphine by ammonia from a solution of the Hydrochlorate in water; draining; and dissolving it in Water, Spirit, and Meconic Acid. 5½ gr. in 1 fl.oz. *Dose*, 5 to 40 min.

17. **Codeina.**—Codeine. $C_{18}H_{21}NO_3,H_2O$.

Source.—Separated from the ammoniacal liquors from which Morphine has been obtained, by evaporating, treating the residue with water, precipitating with caustic potash, and purifying the precipitated alkaloid by recrystallisation from ether.

Characters.—Nearly colourless octahedra. *Solubility:* 1 in 80 of water and of Liquor Ammoniæ; very readily in diluted acids and in spirit. Aqueous solution is alkaline and bitter. Gives a yellow (not a red) colour when moistened with HNO_3. Yields a colourless solution with H_2SO_4, which, when gently warmed with a trace of Fe_2Cl_6, assumes a deep blue colour. *Dose*, ¼ to 2 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Opium is generally believed to be anæsthetic and anodyne when applied to the unbroken skin; and the Emplastrum, Linimentum, fomentations made from the Tincture, and other preparations are used to relieve the pains of neuralgia, lumbago, abscess, etc. It is doubtful, however, whether Morphine can be absorbed by the unbroken skin; and the benefit derived from these applications may be referable to the spirit, resins, etc., which they also contain, or to the heat which they convey. Wounds, ulcers, and exposed mucous surfaces readily absorb Morphine or Opium, which are used in painful ulcers, conjunctivitis, and similar diseases. Morphine is occasionally given by the *endermic* method, especially in the epigastric region. *Hypodermic injection* is a most valuable means of administration, when a rapid or local effect is specially desired, or when the stomach is irritable or inaccessible.

Internally.—Opium is quickly absorbed by the mucous membrane of the mouth, and exerts an action there which, although in part also specific and in part remote, is chiefly an immediate local one. A full medicinal dose renders the mouth dry and the tongue foul, from **diminution of the secretions,** with thickness of the voice and some thirst. On entering the stomach Opium may cause sickness, from brief irritation of the nerves, but sensibility is quickly reduced; hunger and pain relieved or removed; appetite, gastric secretion, and digestive activity diminished; and the afferent impressions which give rise to vomiting arrested, so that direct emetics will no longer act. Anorexia, nausea, and sickness may occur as *sequelæ* of the same or of larger doses.

These effects of Opium on the stomach have a double bearing in therapeutics. First, they indicate that it has a constant tendency to **derange digestion.** Secondly, it is a powerful means of relieving gastric pain and vomiting, whatever their cause, but especially in the acute catarrh which remains as the effect of irritant food, alcohol, or poison, after these have been removed; in ulcer, "chronic," or malignant; and in reflex sickness, due to disease, irritation, or operation, in some other part of the abdomen. In chronic dyspeptic pain it is manifestly contra-indicated.

The action of Opium on the intestine is distinctly sedative, although very brief primary stimulation may sometimes be recognised. Both the sensible and insensible impressions from the mucous membrane are diminished or arrested by medicinal doses; pain is prevented or relieved; and the secretions become less abundant. At the same time peristalsis is rendered more feeble or is completely arrested by stimulation of the splanchnics, the inhibitory nerves of the intestinal walls. The total result on the bowel is **anodyne and astringent.** Opium is therefore a most valuable remedy for unnatural frequency of the bowels, as in simple diarrhœa, dysentery, the first stage of cholera, the ulceration of typhoid fever and tuberculosis, and irritant poisoning. In all such cases, however, it must be employed with the cautions to be afterwards insisted on; and in most instances it is best prescribed as an addition to other astringents, such as Chalk, Lead, and Tannic Acid in its many forms; the amount of Opium being a minimum, but still sufficient to assist the less powerful drugs. It has the further advantage of relieving abdominal pain. Even infants (see *Cautions*, page 223) may thus be treated for diarrhœa with the greatest benefit. Very large doses of Opium paralyse the splanchnics in animals, increasing peristalsis; and diarrhœa may be observed in man under similar conditions.

Opium is of still greater service in **paralysing the bowels** in hernia, intestinal obstruction, peritonitis, and visceral perforations, ruptures, and wounds. The drug must be freely and continuously given, until nature or art can afford relief.

Given by the rectum, as the Enema or Suppository, Opium relieves local pain, diarrhœa, dysentery, and spasm of the rectum or neighbouring parts; sets the pelvic organs at rest after operations; and prevents irritability of the rectum by nutrient enemata. The dose of Opium by the rectum should be half as much more as by the mouth.

A trace of Morphine is excreted unabsorbed in the fæces.

2. ACTION ON THE BLOOD.

Morphine enters the circulation less quickly than some other alkaloids, although the first traces of the drug are rapidly discovered in the blood. Thus its full action is comparatively slowly developed, and solid Opium continues to exert local effects even in the colon, portion by portion of the Morphine being absorbed into the vessels. The red corpuscles are said to be reduced in size indirectly, possibly through slowing of the circulation and want of oxygen.

3. SPECIFIC ACTION.

After administration Morphine may be found in the organs, all of which, probably without exception, are physiologically affected by it; but its principal action is exerted upon the nervous system.

The *convolutions* are first briefly excited, and afterwards depressed, probably by direct action of the Morphine upon the nerve cells, not on the cerebral vessels. The stage of Opium excitement is said to transcend even the first stage of alcoholic intoxication in the exaltation of feelings, the sense of happiness and comfort, the brilliancy of imagination, and the increase of intellectual power and mental vigour generally, all accompanied by brightness of expression and manner. But the effect of Opium, even in this stage, is rarely one of pure exaltation, and in most persons is perhaps never so. There is generally some perversion of the faculties, and the imagination becomes extravagant, wandering into the land of dreams, of the grotesque, and the impossible. Depression now supervenes: the various perceptive and sensory centres in the convolutions are more or less depressed, according to the dose; impressions made upon the afferent nerves, including pain, do not readily affect the receptive centres; the subject becomes drowsy, and finally sleeps; and if he momentarily respond to a sharp inquiry or other forms of stimulation, he quickly relapses into heavy sopor. If the dose has been excessive, the stage of excitement is entirely absent, the cerebrum is speedily and profoundly depressed, and no response follows severe forms of stimulation, such as flagellation: the patient is comatose. These effects of

Opium on the brain as a **stimulant, anodyne, hypnotic,** and **narcotic,** are more marked in man and in highly intellectual races, than in animals and lower races, respectively. In cold-blooded animals they are quite subordinate to the effects of stimulation of the cord.

The *ganglia at the base of the brain* are affected by Opium, whence **contraction of the pupil** and disturbed accommodation.

The *motor centres in the brain and spinal cord* are at first briefly stimulated by Opium, reflex excitability being increased, as shown by restlessness in man and convulsions in animals. At the stage of cerebral depression, languor and muscular weakness, of central origin, set in, and the subject lies down; but there is not then complete loss of muscular power and irritability, and even in dangerous poisoning the patient can be marched about, if supported on either side.

Following close upon the convolutions and cord, the great vital centres in the *medulla* are markedly affected by Opium. *Vomiting* is not uncommon as one of the first effects. The *respiratory* centre, at first unaffected, is then depressed, the respiratory movements becoming quiet, superficial, and irregular; death by Opium poisoning being due to **paralysis of the respiratory centre** and arrest of breathing, that is, to asphyxia. The *cardiac* centre is more resistant to Morphine: it is first excited so as to increase inhibition (after evanescent acceleration); but it is soon depressed, and the pulse rises in frequency. The *vascular* centre is depressed, but never to a dangerous extent; and even in complete narcosis, when respiration is failing, the blood pressure (pulse) responds to afferent stimuli. The full action of Opium on the respiration, heart, and vessels will be immediately described.

We shall presently find that the therapeutical value of the action of Opium on the central nervous system lies in the fact that it depresses the perceptive and sensory centres so much earlier and more profoundly than the vital centres in the medulla. Its effects on the pupil, heart, vessels, respiration, and cord, are of less positive value in treatment, and in some respects altogether unfortunate.

The functions of the *sensory nerve terminations* are lowered or arrested by Opium, common sensibility being especially reduced, so that pain cannot be originated; but this peripheral anæsthetic or anodyne effect of Morphine given by the mouth is decidedly secondary, both in time and in degree, to its allied action on the sentient centres, and to its local effect when administered by hypodermic injection, already described.

The conductivity of the *sensory nerve trunks* is diminished by local injection of Morphine, as well as by its internal administration; this offering a second interruption to the flow of painful impressions inwards.

The *motor nerves* are first briefly excited, and then paralysed from the centres outwards. *Muscular* irritability is never completely lost.

The action of Opium upon the centres of several of the *viscera* has been partly described under the previous heads. In addition, it **depresses the afferent (including the sensory) nerves of all organs**, and acts upon many of the viscera directly. The *heart* is temporarily accelerated by Opium, in part through the cardiac centre, in part through its intrinsic ganglia. Thereafter, or with fuller doses, it is slowed by stimulation of the vagus in the medulla and heart. Finally, the **cardiac vagus is depressed** or paralysed; but by this time the intrinsic ganglia are so depressed that acceleration is impossible, and the action remains infrequent whilst very feeble. Very rarely death occurs by sudden cardiac failure.

The *vessels*, dilated through the centre, as described, are not *directly* influenced by Opium, either in their muscular coats or in their peripheral nerves.

Whilst the *respiratory* movements of the chest are impaired through the centre, so that they become feeble and tend to cease, the afferent nerves of breathing, that is, the branches of the vagus arising in the lungs and passages, are also depressed. Thus reflexion is dulled or arrested at its very origin, and dyspnœal excitement (hyperpnœa), cough, spasm, and other reflex respiratory acts are rendered more difficult or are altogether prevented. At the same time the bronchial secretions are diminished or inspissated by the action of the drug upon the glands, and the activity of the pulmonary circulation is lowered with the general blood pressure and by the weakening of the respiratory movements. **The total effect of Opium upon the respiratory functions is thus powerfully depressant.**

The biliary and glycogenic functions of the *liver* are affected by Morphine, which may cause pale stools or even jaundice, and remarkably diminishes the amount of sugar in diabetes. **Hepatic and general metabolism is reduced in activity**, the amount of urea and probably of carbonic acid excreted being distinctly diminished. The *temperature* rises for a time, and then falls, apparently varying with the blood pressure.

4. SPECIFIC USES.

The hypnotic and anodyne effects of Opium constitute it by far the most valuable drug of its kind, and the most important article of the whole *materia medica*. It is constantly employed to induce sleep, relieve pain, and calm excitement;

this combination of properties making Opium greatly superior to Chloral and other simple hypnotics, on the one hand, and to Aconite, Belladonna, Quinine, and other direct or indirect anodynes, on the other hand. Speaking broadly, it is used in sleeplessness due to pain; in the insomnia of exhaustion, overwork, fever, or insanity; and in the restlessness and anxiety of visceral disease, the quantity, combinations, and time of administration being carefully arranged. In delirium Chloral is often preferred, especially in delirium tremens; but Opium is more suitable in the delirium of mania, and in the later stages of fevers, when the temperature is falling and the respiration and circulation are not oppressed. It has been recommended, however, in heat pyrexia, combined with Quinine.

There are but few kinds of *pain* that cannot be relieved by Opium; whether it be wise to administer it in every instance is another question. The unbearable pains attending the passage of renal and biliary calculi; the pains of neuralgia, acute rheumatism, and cancer; of fractures, dislocations, and other injuries, are a few examples of conditions in which Opium is essential. In all cases where pain is urgent, and its seat accessible, the hypodermic method should be chosen. In gout it is to be used only when the pain is excessive, as it tends to aggravate the cause. In hysterical pain it is less valuable. Other local visceral pains will be noticed presently. The pain and shock of operations are treated with a full dose of Opium.

No use is made of the action of Opium on the iris and ciliary nerves.

As an antispasmodic, Opium is less employed for various reasons, *e.g.* in epilepsy and other convulsive diseases; but it relieves some cases of spasmodic asthma, whooping-cough, and spasmodic stricture of the urethra.

The violent spasms and pains of certain diseases of the *cord* may yield to no other form of treatment than Morphine hypodermically.

From its action on the medulla, Opium has been recommended as an antidote to Belladonna, which is so far its physiological antagonist, as we shall see (page 224); but it must be used with caution, and only in the stage of excitement.

The practical points connected with the vital centres will now be noticed under the heart, vessels, and respiration:

In diseases of the *heart*, Opium is of great value to relieve pain, anxiety, and distress, whilst, as we have seen, it is a dangerous cardiac depressant. Towards the end of most cases of cardiac disease, the greatest discrimination is called for as to whether Opium may or may not be given. The safe rule is to trust to other anodynes entirely, such as Belladonna, direct and indirect stimulants, and measures for relieving the circulation; but it is equally true that in some cases of heart disease unspeakable relief and permanent benefit may be obtained by the hypodermic injection of Morphine. This subject must be studied in books on the practice of medicine.

From its soothing effect upon the *vessels* and circulation generally, Opium is a **hæmostatic** of the first order, but requires to be used with judgment. In hæmoptysis it is given in moderate doses, to relieve cough, to depress the circulation slightly by slowing and weakening the heart and dilating the vessels, and to relieve the mind of the anxiety which aggravates the bleeding. In intestinal hæmorrhage it is of great value, arresting, as it also does, the movements of the bowel. It is best given with Lead or preparations containing Tannic Acid.

The soothing influence of Opium on the bronchi, lungs, the afferent nerves and the centre of *respiration*, accounts for its extensive employment in cough, pain, dyspnœa, and other distressing symptoms in the chest. Its power here is unquestionable; but for this very reason the danger attending it is great. Cough and dyspnœa are frequently beneficial acts, and are not to be arrested in a routine fashion by sedatives, but, if possible, by the removal of their cause. When cough is due to some irremovable condition, such as a growth in the lungs or bronchi, to pressure, to remote (reflex) irritation, or to excessive irritability of the nerves and centre, Opium is indicated, and may be given with benefit. On the other hand, in cough and respiratory distress with abundant secretion, as in the bronchitis of the old and infirm or of the very young and feeble, Opium leads to retention and inspissation of the products, aggravation of the cause, and asphyxia, and is on no account to be given. Between these extremes lies every variety of case in which Opium may suggest itself, *e.g.* in phthisis and recurrent bronchial catarrh. The rules of practice here should be not to prescribe Opium unless other means have failed, such as the many expectorants, and attention to food, warmth, etc.; and that, when given, Opium must be ordered in small doses combined with expectorants, such as Ammonia and Ipecacuanha, which will prevent dangerous depression of the local nerves and centres. In acute inflammation of the pleura, or pleuro-pneumonia, it may be necessary to relieve severe pain in the chest, harassing cough, sleeplessness, and mental distress by Morphine hypodermically. For asthma, Opium must be ordered with the greatest hesitation, as the Opium habit is readily acquired in this disease. Its employment in hæmoptysis has been already noticed.

With respect to the *liver and metabolism*, Opium is by far the most powerful drug known for reducing or removing sugar from the urine in diabetes, and therewith ameliorating the condition of the patient in most respects. Very large doses of solid Opium, Morphine, or better still, Codeine, may be tolerated in this disease, their effect on the nervous system being remarkably absent whilst the diabetes is yielding. Acute inflammatory and febrile diseases are now less frequently treated with Opium than formerly, when a combination with Calomel was in general use, the Opium preventing the purgative action of the mercurial, and the latter preventing constipation, whilst both drugs were believed to act specifically on the morbid process, reducing the local and general circulation, alleviating pain and restlessness, and promoting healing. The combination is, moreover, very valuable in syphilis. In the specific fevers, such as typhoid, Opium given with judgment relieves delirium, as we have seen, checks diarrhœa, and is invaluable in hæmorrhage, perforation, or peritonitis. With Quinine it is given in some cases of malaria. Phagedæna and some other kinds of ulceration may call for its free exhibition.

Opium is employed in obstetrics to prevent abortion, in some varieties of difficult labour, and to relieve after-pains.

5. REMOTE LOCAL ACTION AND USES.

The excretion of Morphine commences quickly, but may not be completed for forty-eight hours. It passes out of the body by most of the secretions, especially the urine, where it is found mainly unchanged. **The quantity of urine may be diminished**; its evacuations sometimes disturbed or difficult, from the local action of Morphine on the nervo-muscular mechanism of the bladder; sugar is occasionally present. These facts, and the probability of the retention and accumulation of Morphine in the system if the action of the kidneys be deficient, indicate the necessity to give it only with the greatest caution, in reduced doses, or not at all, in renal disorder or disease.

Morphine in passing through the *skin* may cause itching, heat, and sometimes eruptions. The vessels are also dilated, as we have seen, and the sweat glands decidedly stimulated; both being effects of its central, not of its local cutaneous action. Thus Opium, especially in the form of Dover's Powder, is a valuable **diaphoretic**, and is given with great success as a refrigerant apyretic in the onset of catarrh, influenza, and mild febrile or rheumatic attacks caused by cold. Under certain circumstances, Dover's Powder checks the sweating of phthisis, probably by removing its cause. Being excreted in the milk, Morphine must be prescribed with caution to nursing females.

6. ACTION AND USES OF THE PRINCIPAL CONSTITUENTS OF OPIUM.

1. **Morphine.—The action of opium depends chiefly on morphine**, and the description just given applies so nearly to the pure alkaloid, that only a few points of difference require to be noticed. These depend upon two principal circumstances: (1) Opium, being much less soluble than the pharmacopœial preparations of Morphine, is more slowly absorbed, and thus acts less quickly than Morphine, whilst its effects are more lasting, and its immediate local action on the intestines is decidedly more marked. (2) Several of the constituents of Opium possess more or less convulsant action (Thebaine, Codeine, Narcotine), Morphine none (in man); the latter has therefore a more sedative influence than the entire drug. The effect of Morphine on the skin is also less marked than that of Opium. Unless there be some special reason to the contrary, Morphine is generally to be preferred to Opium in practice, as being of definite composition (whilst the crude drug is very variable), more rapid in action, and readily administered hypodermically, whilst the dyspeptic and constipating effects of the drug are less marked. Opium is to be preferred in intestinal and abdominal diseases, such as diarrhœa, obstruction, peritonitis, and hernia, because it reaches the bowel directly; in delirium tremens and mental disorder, because its action is more continued; in diabetes, because it contains Codeine; for combinations with Quinine or Calomel, and as a diaphoretic, because it prevents purgation and lowers fever; in astringent enemata, from its action on the bowel; and for local applications, *e.g.* to the conjunctiva, because less irritant than the alkaloid. The relative strength of Opium to Morphine is about 20 or 30 to 100, $\frac{1}{5}$ or $\frac{1}{3}$ to 1.

2. **Codeine.**—This alkaloid appears to **excite the cord** more than Morphine, and to depress the convolutions less, so that muscular tremors may follow and exceed the sedative influence. Codeine, in $\frac{1}{2}$-gr. doses cautiously increased, markedly **reduces the amount of sugar** in diabetes, appearing to act as an alterative to the nervous system, and thus to cure (not simply relieve) the disease in some instances.

3. *Narcotine*, which is so large a constituent of Opium, is probably often impure from an admixture of Morphine. By some authorities it is considered to be **hypnotic**, by others convulsant. It is not used.

4. *Narcein* probably **acts like morphine**, and is not employed medicinally.

5. *Thebaine* is a **convulsant**, almost like Strychnine.

6. Opianine, Cryptopine, Metamorphine, and possibly Papaverine, **act like Morphine.** Porphyroxin and Laudanin **act like Codeine.**

7. The action of *Meconic Acid* is doubtful.

7. APPLICATIONS OF THE VARIOUS PREPARATIONS OF OPIUM.

This subject will be best discussed from the point of view of the conditions calling for Opium.

1. *Severe pain*, such as colic or neuralgia, is to be treated with the Hypodermic Injection of Morphine. Failing this, either of the Solutions of Morphine must be given by the mouth, or a fluid preparation of Opium, such as the Tincture, or the Liquid Extract (about one-seventh more active than the Tincture). The Enema is a valuable anodyne in cases of abdominal pain. The Pilula Saponis Composita also acts rapidly, being more readily soluble in the stomach than solid Opium.

2. *Superficial pain* may be met by local applications, such as the Plaster, Liniment, or fomentations made with Laudanum or other fluid preparation; but, as we saw, the value of the drug itself in all these applications is very doubtful.

3. *As a hypnotic*, the best forms are the Tincture, the Liquid Extract, the Solutions of Morphine, and the Soap and Opium Pill; the particular preparation and the dose being regulated by the degree of sleeplessness and by the pain which may accompany it. Dover's Powder is an excellent hypnotic in the restlessness at the commencement of feverish attacks.

4. As a *sedative to the stomach*, various preparations may be tried, such as the Solutions of Morphine in effervescing mixtures, Morphine endermically or hypodermically to the epigastrium; sometimes solid Opium or the Extract in the form of a small pill. Dover's Powder combined with Bismuth or Soda is of value in painful ulceration and acute dyspepsia.

5. As a *sedative and astringent to the bowels*, Laudanum, either by the mouth or as the Enema, may be given in urgent cases attended by much pain. When there is less urgency, we may prescribe one of the powders: Compound Opium Powder, Chalk and Opium, Kino and Opium, or Dover's Powder. Acetate of Morphine with Acetate of Lead and Acetic Acid, or the Lead and Opium Pill may be demanded in severe diarrhœa, especially if hæmorrhage threaten. Solid Opium, alone or combined with Calomel, is the best form of sedative when the bowel must be paralysed, as in hernia, peritonitis, and intestinal obstruction.

6. As *sedatives to the rectum*, bladder, pelvic organs, and urethra, we possess the various Suppositories of Opium and Morphine, and the Enema.

7. *Cough* may be relieved by several special preparations, namely: Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, the Trochisci, and Pilula Ipecacuanhæ cum Scillâ.

8. *Diaphoresis* may be accomplished with Dover's Powder.

The uses of the other preparations are obvious. The Confection is a pleasant form of the Compound Powder.

Influences modifying the action and uses of Opium. Dangers: Cautions.—*Age* greatly modifies the effects of Opium, children being particularly susceptible of its influence on the convolutions and medulla. An infant of one year should not be given more than half a minim of the Tincture for an ordinary dose, and suckling women should be ordered Opium with special precautions. *Females* are more easily affected than males. Certain individuals have peculiar *idiosyncracies* as regards Opium, some resisting its action, others being excited by it, others again very readily narcotised; whilst more frequently some persons suffer from a species of shock after the hypodermic injection of Morphine, becoming sick, faint, and even alarmingly collapsed. The effect of *habit* is extremely marked in Opium, the necessary dose steadily rising, until large quantities may be safely taken. *Disease*, especially *pain*, affords great resistant power to the action of Opium, which appears to expend itself on the morbid process. The quality of the Opium, the particular preparation, and the combinations used, also modify its action. On the contrary, Opium and Morphine act more powerfully in the subjects of kidney disease, as we have already seen. Morphine and Opium are *contra-indicated* because dangerous, or they are to be used with special care, in diseases of the respiratory organs, the heart, and the kidneys; in congestive conditions and hyperæmia of the brain; and in alcoholic intoxication.

Opium and Belladonna: Combinations and Antagonism of Morphine and Atropine.—In several respects the action of Morphine is opposed to that of Atropine, the active principle of Belladonna. The *antagonism* between the two substances is in part real, such as their respective effects on the convolutions, respiratory centre, and intestines. In part it is apparent only. Thus, the contraction of the pupil caused by Morphine occurs through the basal ganglia; the dilatation caused by Atropine is referable to paralysis of the ciliary branches of the third nerve. Morphine is a diaphoretic through the centres; Atropine an anhidrotic through the terminal nerves of the glands. Both depress the heart, and reduce the blood pressure, in poisonous doses. Thus Morphine and Atropine are not true antagonists, but the one may prevent or relieve certain effects of the other, and may therefore be combined with the other for particular medicinal purposes, or given in the treatment of poisoning by the other under particular circumstances.

Combinations of Atropine and Morphine are now used for hypodermic injection ($\frac{1}{100}$, $\frac{1}{50}$, or even $\frac{1}{10}$ gr. of Sulphate of Atropine, to each grain of Acetate of Morphine) to prevent certain unpleasant effects of the latter. It is found that the immediate sickness and depression, and the subsequent dyspepsia and constipation, may thus be avoided, and a more natural sleep induced. The combination is preferable when Morphine is given as a hypnotic or anodyne; in conditions of cardiac depression and disease of the lungs; in obstruction of the bowels; and to relieve spasms. The Atropine should be avoided in cerebral excitement, especially mania.

Use as mutual antidotes.—Sulphate of Atropine, in doses of $\frac{1}{10}$ gr., may be injected subcutaneously every quarter of an hour in Opium poisoning, the pulse and respiration being carefully watched. Three or four doses may thus be given; but the ordinary means of resuscitation, especially artificial respiration, must not be for a moment interrupted.

In poisoning by Belladonna, Morphine should be given subcutaneously, with the same precautions, in doses of $\frac{1}{4}$ gr.

Apomorphinæ Hydrochloras.—HYDROCHLORATE OF APOMORPHINE. $C_{17}H_{17}NO_2,HCl$. The hydrochlorate of an alkaloid obtained by heating Morphine or Codeine in sealed tubes with Hydrochloric Acid, $C_{17}H_{19}NO_3 = C_{17}H_{17}NO_2 + H_2O$, the alkaloid losing one molecule of water.

Characters.—Small, greyish-white, shining needles, turning green on exposure to light and air, inodorous, very faintly acid. *Solubility:* completely in water and in spirit. Solutions become decomposed and green when boiled; give with $NaHCO_3$, a precipitate which becomes green on standing, and then forms a purple solution with ether, violet with chloroform, and blueish-green with alcohol. With dilute solution of perchloride of iron it gives a deep red, with nitric acid a blood-red, coloration. *Dose.*—$\frac{1}{10}$ to $\frac{1}{6}$ gr. by the mouth; $\frac{1}{25}$ to $\frac{1}{10}$ gr. hypodermically.

Preparation.

Injectio Apomorphinæ Hypodermica.—2 gr. dissolved in 100 min. of Camphor Water. Should be prepared as required. *Dose*, subcutaneously, 2 to 5 min.

ACTION AND USES.

Apomorphine is the most certain of all emetics, acting upon the vomiting centre, and not on the stomach, *i.e.* being an **indirect emetic.** In from five to twenty minutes it causes moderate nausea, repeated vomiting, and the disturbances of the respiratory and circulatory organs produced by emetics. (*See* page 449.) If the dose have been sufficient, the evacuation of the stomach is certain and complete. Larger doses cause prostration and paralysis of the voluntary muscles, depression of the respiratory centre, acceleration of the heart, and fall of temperature. Small doses are **expectorant.** Apomorphine may be used for the many purposes of emetics in general. Its special advantages consist in its certainty; the absence of local irritation of the stomach; the readiness with which it can be given hypodermically, that is to patients unable to swallow, as a small non-irritant injection; and the absence of after-effects. Its expectorant action has been as yet but little employed.

Rhœados Petala.—RED-POPPY PETALS. The fresh petals of Papaver Rhœas. Indigenous.

Characters.—Scarlet; with heavy poppy odour; bitter.

Composition.—Red Poppies contain 40 per cent. of red colouring matter, readily soluble in water, consisting of *papaveric* and *rhœadic acids;* an alkaloid *rhœadine*, $C_{21}H_{21}NO_6$, without narcotic properties; but no Morphine.

Preparation.

Syrupus Rhœados.—1 in 3½. *Dose*, 1 fl.dr.

ACTION AND USES.

Syrup of Red Poppies is used as a colouring agent only.

CRUCIFERÆ.

Sinapis Albæ Semina. — WHITE MUSTARD SEEDS. The dried ripe seeds of Brassica alba. From plants cultivated in Britain.

Characters.—About $\frac{1}{12}$ of an inch in diameter, roundish, pale yellow, very finely pitted, hard; internally yellow, oily. Inodorous; taste pungent.

Sinapis Nigræ Semina.— BLACK MUSTARD SEEDS. The dried ripe seeds of Brassica nigra. From plants cultivated in Britain.

Characters.—Scarcely half the size of White Mustard Seeds, roundish, dark reddish- or greyish-brown, finely pitted, hard; internally yellow. Inodorous when dry, even when powdered, but when rubbed with water exhaling a strong pungent odour and irritating the eyes; taste very pungent.

Substances resembling Black Mustard: Colchicum Seeds, which are larger, lighter, and not quite round.

Composition.—The seeds of *Sinapis nigra* contain: (1) about 35 per cent. of a bland *fixed oil.* When this has been expressed, and the powdered mustard mixed with water at 120° and distilled, there is obtained (2) the official *volatile oil, Oleum Sinapis*, C_3H_5CNS, sulphocyanate of allyl; sp. gr. 1·015. This is a colourless or pale yellow body, of intensely penetrating odour, burning taste, and blistering action on the skin. As the seeds and powder of the mustard are devoid of these irritant properties, the oil cannot exist ready formed in them, but is developed by a decomposition of their constituents. On the addition of water to the Black Mustard, its most important principle, *potassium myronate* or *sinigrin* $KC_{10}H_{18}NS_2O_{10}$ (a compound of potassium with an acid glucoside, *myronic acid*), is broken up by another constituent, *myrosin*, a ferment, into volatile oil of mustard, potassium sulphate, and sugar, thus: $KC_{10}H_{18}NS_2O_{10} = C_3H_5CNS + KHSO_4 + C_6H_{12}O_6$. *Sinapis alba* also contains (1) the fixed oil. It does not, however, yield the volatile oil, but (2) a substance with allied properties, called *sulphocyanate of acrinyl*, C_7H_7CNSO, by a similar decomposition of its constituents, *sinalbin*, $C_{30}H_{44}N_2S_2O_{16}$ (in place of potassium myronate) and myrosin; thus: $C_{30}H_{44}N_2S_2O_{16} = C_7H_7CNSO + C_{16}H_{23}CNO_5,H_2SO_4$ (disulphate of sinapin) + $C_6H_{12}O_6$ (glucose).

From Sinapis Nigræ Semina is made:

Oleum Sinapis.—The oil distilled with water from Black Mustard Seeds after expression of the fixed oil.

Characters.— Pale yellow; intensely pungent and irritant. *Solubility.*—1 in 50 of water; readily in spirit and ether. Boils at 298° Fahr. Sp. gr. 1·015 to 1·020.

Preparation.

LINIMENTUM SINAPIS COMPOSITUM.—Oil, 1·4; Ethereal Extract of Mezereon, 1; Camphor, 3; Castor Oil, 7; and Spirit, 44.

Sinapis.—MUSTARD. Black Mustard Seeds and White Mustard Seeds powdered and mixed.

Characters. — A greenish-yellow powder, of an acrid bitterish oily pungent taste, scentless when dry, but exhaling when moist a pungent penetrating peculiar odour, and very irritating to nostrils and eyes. *Impurities.*—Starch and flour.

Preparations.

1. **Cataplasma Sinapis.**—Mustard and Linseed Meal equal parts; mixed, the former with tepid water, the latter with boiling water; and stirred together.
2. **Charta Sinapis.**—Cartridge Paper, coated with a mixture of Mustard in Guttapercha Solution; and dried.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—When applied to a limited area of skin, Mustard acts quickly (1) as a **rubefacient** and nervous **stimulant**, causing redness, heat, and severe burning pain. (2) This effect is followed by **loss of sensibility** in the part to other impressions, and relief of previous pain. (3) The prolonged application of the Charta or Cataplasm causes **vesication**, by the production of local inflammation. Neighbouring and deeper parts, and viscera in vascular communication or intimate nervous relation with the blistered area, may thus have their circulation relieved. The heart, blood pressure, respiration, and nervous centres generally are stimulated by the first application of Mustard to the skin; soothed during the stage of anæsthesia, and relief of pain; and depressed in the third stage, especially if the vesication be severe through neglect. Applied to the whole or a large part of tho surface of the skin in the form of a bath, Mustard dilates the cutaneous vessels, and thus relieves the blood pressure in the viscera.

In the form of Poultice or Paper, Mustard is extensively used as a readily available, convenient, and rapid means of relieving local pain, stimulating the internal organs, and producing **counter-irritation**, with evanescent and mild after-effects. It is applied to relieve the pains of muscular rheumatism (lumbago, etc.); neuralgia in any part of the body; the indefinite pains in the chest in chronic disease of the lungs or heart; and colic, gastralgia, and other forms of distress in the abdomen. As a cardio-vascular and respiratory stimulant, a large sinapism may be applied to the calves or soles in syncope, coma, or asphyxia, whether from disease or from poisoning. The counter-irritant effect of Mustard is chiefly used in inflammation of the throat, larynx, bronchi, lungs, pleura, and pericardium; sometimes in abdominal diseases; frequently, and with success, in morbid conditions of the stomach, and persistent vomiting from any cause. Diffused through a warm bath it is a popular "derivative" in cerebral congestions, in headache, and at the onset of colds and febrile diseases in children. A Mustard sitz bath may stimulate menstruation if taken at the period.

Internally.—Mustard produces a familiar pungent impression on the tongue and olfactory organs, a sense of warmth in the stomach, an increase of relish and appetite and of the circulation in the gastric wall. It is therefore the most familiar of condiments. In full doses it is **emetic**, with a rapid stimulant action and but little subsequent depression. From one to four teaspoonfuls may be given, stirred up with a tumblerful of warm water in cases where other emetics are not available or have failed, especially in poisoning by narcotics.

2. ACTION IN THE BLOOD, SPECIFIC, AND REMOTE LOCAL ACTION.

The odour of Oil of Mustard can be detected in the blood. Its specific action is obscure, and never taken advantage of medicinally. Part of Oil of Mustard is excreted by the lungs.

Armoraciæ Radix.—HORSERADISH ROOT. The fresh root of Cochlearia Armoracia. Cultivated in Britain; most active in the autumn and early spring, before the leaves have appeared.

Characters.—A long cylindrical, fleshy root, ½ to 1 inch in diameter; pale yellowish- or brownish-white externally, whitish and fleshy within; taste pungent; odour pungent when bruised. *Substance resembling Horseradish:* Aconite Root, which is short, conical, darker, and causes tingling when chewed.

Composition.—Horseradish yields, along with other constituents, a *volatile oil*, $C_3H_5.CNS$, closely allied to the volatile oil of black mustard, and formed, like it, by decomposition of a more complex principle by means of a ferment.

Preparation.

Spiritus Armoraciæ Compositus.—1 in 8, by distillation, with Bitter Orange-peel, Nutmeg, Proof Spirit, and Water. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Horseradish has been used in domestic medicine as a counter-irritant, but is most familiar as a pleasant condiment, possessing much the same properties as Mustard. The Compound Spirit is a flavouring and carminative agent.

POLYGALACEÆ.

Senegæ Radix.—SENEGA ROOT. The dried root of Polygala Senega. From North America.

Characters.—Enlarged above into an irregular knotty tuberosity, bearing the remains of numerous small stems; tapering below into a twisted, branched, and keeled root, $\frac{1}{5}$ to $\frac{1}{3}$ of an inch thick. Bark yellowish- or brownish-grey, transversely cracked. Fracture short, brittle. Odour of bark peculiar, rancid; taste at first sweetish, afterwards very acrid, sourish, causing a flow of saliva. Central column woody, tasteless, and inodorous. *Substances resembling Senega:* Veratrum viride, Arnica, Valerian, Serpentary. All these have no keel.

Composition.—The active principle of Senega is *saponin*, a colourless amorphous glucoside, $C_{32}H_{54}O_{18}$, yielding a frothy solution with water, and decomposed by HCl into a sugar and *sapogenin* ($C_{14}H_{22}O_2$). Saponin is closely allied to *digitonin*, one of the active principles of Digitalis.

Preparations.

1. **Infusum Senegæ.**—1 in 20 of boiling Water. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Senegæ.**—1 in 8 of *Proof* Spirit. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied to the mucous membrane of the nose or throat, in the form of powder (snuff), Senega is a powerful irritant, causing reflex hyperæmia, sneezing, cough, and mucous flow. These effects of the drug are not employed therapeutically, but are a key to its remote local action. Solutions of Saponin injected under the skin are violent local irritants and general depressants; the heart, vessels, central and peripheral nervous system, and muscles being all affected.

Internally.—The action of Senega on the stomach and intestines is moderately irritant, large doses causing epigastric heat, sickness, and diarrhœa; and medicinal doses deranging

digestion. The absence of severe general symptoms indicates the difficulty of its absorption by the stomach.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION AND USES.

Saponin passes through the blood to the tissues, diminishes the frequency of the heart, and probably affects the circulation much like Digitalis, but in a manner which is more uncertain.

It appears to be excreted in part by the bronchial mucosa, which it stimulates remotely as it does when locally applied. The circulatory, muscular, and nutritive activity of the tubes is increased; the mucous secretion rendered more abundant and watery; and the afferent nerves stimulated, so that reflex cough is the result. The total action is said to be **expectorant,** the bronchial contents being expelled in greater volume and with greater force, *i.e.* more readily and easily. Senega is in common use as a stimulant expectorant, being given in the second stage of acute bronchitis, in chronic bronchitis, and in dilated bronchi, to liquefy and evacuate the contents of the tubes or cavities, and stimulate the "weak" surface of the mucous membrane. It is contra-indicated in the first stage of acute bronchitis, in phthisis, and when digestion is feeble or deranged. Saponin is probably excreted in part by the skin and kidneys, both of which it stimulates, increasing the volume of the urine and its most important solid constituents.

Krameriæ Radix. — RHATANY ROOT. The dried root of (1) Peruvian Rhatany, Krameria triandra; and of (2) Savanilla Rhatany, Krameria Ixina.

Characters.—1. *Peruvian* Rhatany is in branched or unbranched pieces. It consists of (*a*) a readily separable bark, $\frac{1}{20}$ to $\frac{1}{10}$ of an inch thick, rough and scaly except in the smaller pieces, dark reddish-brown externally, bright brownish-red within; and (*b*) a hard brownish- or reddish-yellow woody axis. 2. *Savanilla* Rhatany is less irregular and knotty, not so long or thick, dark purplish or violet, with smooth, thicker, adherent bark, marked by transverse cracks. The bark of both kinds has a strongly astringent taste, and tinges the saliva red; odour not marked. Wood nearly tasteless and inodorous.

Composition.—Rhatany Root contains from 20 to 45 per cent. of *rhatania-tannic acid*, $C_{54}H_{24}O_{21}$, a red amorphous substance, the watery solutions of which first colour perchloride of iron green and then precipitate it, but are not precipitated by tartar emetic. *Incompatibles.*—Alkalies, lime-water, salts of iron and lead, and gelatine.

Preparations.

1. **Extractum Krameriæ.**—Aqueous. *Dose*, 5 to 20 gr.
2. **Infusum Krameriæ.**—1 in 20. *Dose*, 1 to 2 fl.oz.
3. **Pulvis Catechu Compositus.**—1 in 5. *See* page 300.
4. **Tinctura Krameriæ.**—1 in 8 of *Proof* Spirit. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

The preparations of Rhatany possess the **properties** of **Tannic Acid**, and may be employed for the same purposes (see *Acidum Tannicum*, page 371), except that they are obviously of no use in poisoning by antimony.

SAPINDACEÆ.

Guarana.—(*Not official.*) The seeds of Paullinia sorbilis, reduced to powder after roasting, and made into a stiff paste with water. Brazilian Cocoa.

Characters.—Cylindrical rolls of dried paste.

Composition.—Guarana contains no less than five per cent. of *caffeine*, $C_8H_{10}N_4O_2,H_2O$, the alkaloid of the coffee and tea plants; united, as in these, with *tannic acid*, *starch*, and *gum*. (*See* page 301.) *Dose*, 15 to 60 gr. in powder, or as infusion.

ACTION AND USES.

The action of Guarana closely **resembles that of strong tea** or coffee. It is chiefly used in megrim. See *Caffeina*.

ERYTHROXYLACEÆ.

Coca.—COCA. CUCA. The dried leaves of Erythroxylon Coca. From South America.

Characters.—Shortly stalked, oval or lanceolate, 1 to 2 inches or more in length, entire, usually blunt and emarginate, smooth; midrib prominent, with numerous faint anastomosing lateral veins, and a curved line on each side of the midrib, from base to apex; green above, paler beneath. Odour faintly tea-like; taste bitter and aromatic.

Composition.—Coca Leaves contain about 0·2 per cent. of an alkaloid, *cocaine*; a second alkaloid, *ecgonine*, $C_9H_{15}NO_3$; *hygrin*, an aromatic substance; *coca-tannin*, and *coca-wax*. Cocaine, $C_{17}H_{21}NO_4$, occurs in shining monoclinic prisms, freely soluble in chloroform, less soluble in water and in alcohol. It yields ecgonine, benzoic acid, and methyl-alcohol, when heated with strong HCl. *Dose of the leaves*, ½ to 2 dr., infused in hot water.

Preparation.

Extractum Cocæ Liquidum.—1 in 1 with Proof Spirit. *Dose*, ½ to 2 fl.dr.

From Coca is made :

Cocainæ Hydrochloras.—Hydrochlorate of Cocaine. $C_{17}H_{21}NO_4,HCl$.

Source.—Obtained by agitating with Ether an aqueous solution of an acidulated alcoholic extract, made alkaline with Carbonate of Sodium; separating and evaporating the ethereal liquid; purifying the product by repeating the treatment with acidulated water, Carbonate of Sodium, and Ether; decolorising; neutralising with Hydrochloric Acid; and recrystallising.

Characters.—Colourless needles or a crystalline powder, readily soluble in water, alcohol, and ether. Its solution in water has a bitter taste; produces on the tongue tingling, followed by numbness. It gives a yellow precipitate with chloride of gold; and a white precipitate with carbonate of ammonium, soluble in excess of the reagent. *Dose*, $\frac{1}{5}$ to 1 gr.

Preparation.

LAMELLÆ COCAINÆ.—Discs of Cocaine. Discs of Gelatine, with some Glycerine, each weighing about $\frac{1}{50}$ gr., and containing $\frac{1}{200}$ gr. of Hydrochlorate of Cocaine.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

A solution of Hydrochlorate of Cocaine has a powerful local action when administered hypodermically, or applied to an exposed mucous surface such as the tongue or conjunctiva, rapidly paralysing the sensory nerves, and contracting the vessels. It thus **produces local anæsthesia and anæmia,** which last for fifteen minutes or more, according to the strength of solution used, and may be followed by temporary dilatation of the vessels. In aqueous solutions of 2 to 20 per cent. the Hydrochlorate is used as a local anæsthetic, to prevent or remove the pain attending minor operations on the surface of the body, and of special value in the surgery of the eye, nose, ear, throat, teeth, rectum, vagina, and urethra. A 4 per cent. solution is commonly used, being applied once or twice before operation at intervals of a few minutes. Examinations of the eye and throat are also greatly facilitated by the previous application of Cocaine. In painful or nervous affections of the same parts, such as neuralgia, burns, itching, whooping cough, tubercular laryngitis, and hay fever, it is also of use, strong applications being avoided as likely to increase the subsequent congestion of the parts. Its local application to the conjunctiva is followed in six or eight minutes by temporary dilatation of the pupil and impairment of accommodation, effects apparently due to irritation of the sympathetic.

2. SPECIFIC ACTION AND USES.

Coca is **stimulant, tonic, and restorative** when given internally, enabling persons who chew the leaf to undergo great muscular exertion with little or no fatigue. In animals it causes great muscular restlessness or excitement, and finally convulsions of cerebral origin; the whole brain, medulla, and cord being powerfully stimulated from above downwards. Very large doses paralyse the posterior columns of the cord and the peripheral sensory nerves, but do not affect the motor tract. The muscles remain unaffected. The pupils are dilated by internal, as by local administration. Respiration rises in frequency, is disturbed in rhythm, and finally ceases. The heart is greatly accelerated by paralysis of the vagus; the blood pressure first rises and then falls. The amount of urea is said to be diminished, as if from diminished metabolism; but Coca does not prolong the life of starved animals. The temperature may be raised.

This drug has been used to prevent muscular exhaustion; in some forms of nervous and muscular debility, and in wasting attended by increased formation of urea; in convalescence; in mental exhaustion; and in the alcoholic and opium habits.

LINACEÆ.

Lini Semina.—Linseed. The dried ripe seeds of Linum usitatissimum, Flax. Cultivated in Britain.

Characters.—Small, flat, oval, pointed, with acute edges; brown, smooth, shining externally, yellowish-white within; odourless; of a mucilaginous oily taste.

Composition.—The seeds of Flax contain a quantity of *mucilage*, chiefly in the testa or coat, and from $\frac{1}{4}$ to $\frac{1}{2}$ of their weight of the official *fixed oil*. This consists chiefly of glyceryl united with *linolëic acid*, which has a powerful affinity for oxygen, and thus becomes resinoid on exposure, constituting it a "drying oil." The Linseed Meal, after expression of the oil, consists chiefly of mucilage, proteids, salts, a little oil, but neither starch nor sugar.

Preparations.

1. **Farina Lini.**—Linseed Meal. Linseed reduced to powder.

   From Farina Lini is prepared:

   CATAPLASMA LINI.—Mix gradually Linseed Meal, 4, with boiling Water, 10; stirring constantly.

   Linseed Meal is also used in preparing: Cataplasmata Carbonis, Conii, Sinapis, and Sodæ Chlorinatæ.

2. **Infusum Lini.**—"Linseed Tea." Linseed, 150 gr.; Liquorice, 50 gr.; boiling Water, 10 fl.oz. Infused two hours. *Dose*, ad libitum.
3. **Oleum Lini.**—Made by expression without heat. Viscid, yellow, with faint odour and bland taste. Thickens by exposure to air.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Linseed Meal is used only as the Cataplasma, which is the poultice universally employed to **convey heat and moisture** to parts, and thus affect the nerves, circulation, and nutrition generally. The Oil may be applied to burns, either pure or mixed with an equal quantity of Lime-water, constituting Carron Oil, a substitute for Linimentum Calcis. It may also be used as a laxative in the form of enema.

Internally.—Infusum Lini, "Linseed Tea," is a familiar **demulcent** drink, containing a large quantity of mucilage, which coats the surface of the pharynx and fauces, and thus relieves troublesome throat cough, especially when it is combined with a little stimulant Lemon.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Linseed Tea is supposed to have a specific or remote local effect as a demulcent on the bronchi and urinary passages, but this is probably referable to the warm water only. It is, perhaps, **slightly diuretic**, as Oil of Linseed becomes oxydised in the system (as it does on exposure to air), and is excreted by the kidneys as a resinoid body which stimulates these organs.

MALVACEÆ.

Gossypium. — COTTON WOOL. COTTON. The hairs of the seed of Gossypium barbadense, and of other species of Gossypium, from which fatty matter and all foreign impurities have been removed.

Characters.—White soft filaments, each consisting of an elongated tubular cell, under the microscope appearing as a flattened twisted band with slightly thickened rounded edges; inodorous; tasteless. Readily wetted by water, without yielding either an alkaline or acid reaction.

From Gossypium is made:

Pyroxylin.—Gun Cotton. Made by immersing Cotton Wool in a mixture of Sulphuric and Nitric Acids, washing, draining, and drying. Readily soluble in a mixture of Ether and Rectified Spirit; leaves no residue when exploded by heat.

Preparations.

1. **Collodium.**—Made by dissolving Pyroxylin, 1; in Ether, 36; and Rectified Spirit, 12.

From Collodium is prepared:

COLLODIUM FLEXILE.—Collodion, 48; Canada Balsam, 2; and Castor Oil, 1.

2. **Collodium Vesicans.**—Pyroxylin, 1; dissolved in Blistering Liquid, 20.

ACTION AND USES.

The action and uses of Cotton Wool are sufficiently familiar.

Pyroxylin is introduced for the purpose of making Collodion.

Collodion, when painted on the skin or other exposed part, instantly dries by evaporation of the ether, forming a fine film. This film serves as a **protective** to thin, inflamed, broken, or incised surfaces; preventing bed-sores, arresting hæmorrhage (as in leech bites), and closing fissures or punctures made with aspirateurs or trocars in paracentesis. The *Flexible Collodion* does not contract on drying, nor readily crack, and is a better form for most of the above purposes.

The root-bark of the cotton plant is believed to be ecbolic.

AURANTIACEÆ.

Aurantii Cortex.—BITTER-ORANGE PEEL. The dried outer part of the rind or pericarp of Citrus vulgaris. From the south of Europe.

Characters.—Thin pieces or strips, of a dark orange colour, nearly free from the white inner part of the rind; odour fragrant; taste aromatic, bitter.

Composition.—Orange Peel contains 1 to 2½ per cent. of volatile oil, *oleum corticis aurantii*, isomeric with oil of turpentine, $C_{10}H_{16}$, and a bitter crystalline principle, *hesperidin.*

Preparations.

1. **Infusum Aurantii.**—1 in 20. *Dose*, 1 to 2 fl.oz.
2. **Infusum Aurantii Compositum.** — 4, with fresh Lemon Peel, 2; Cloves, 1; Water, 160. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Aurantii.**—1 in 10 of *Proof* Spirit. *Dose*, 1 to 2 fl.dr.

From Tinctura Aurantii is prepared:

SYRUPUS AURANTII.—1; Syrup, 7. *Dose*, 1 fl.dr.

Tinctura Aurantii is an ingredient of Mistura Ferri Aromatica and Tinctura Quininæ; *Syrupus Aurantii of* Confectio Sulphuris.

4. **Vinum Aurantii.**—Made in Britain by fermentation of a saccharine solution, to which fresh Orange Peel has been added. Contains 10 to 12 per cent. of alcohol.

Vinum Aurantii is used in making Vinum Ferri Citratis and Vinum Quininæ.

Bitter Orange Peel is also an ingredient of Spiritus Armoraciæ Compositus, Tinctura Cinchonæ Composita, Infusum Gentianæ Compositum, and Tinctura Gentianæ Composita.

Elixir Aurantii (U.S.P.). Oil of Orange, 1; Sugar, 100; Alcohol and Water (1 to 3), to 300. *Dose*, 1 fl.dr.

Aurantii Fructus.—BITTER ORANGE. The ripe fruit of Citrus vulgaris. From the south of Europe.

Characters.—Globular, with compressed ends. Pericarp rougher and darker, and rind more aromatic, than in the Sweet Orange. Pulp very bitter and sour.

Preparation.

Tinctura Aurantii Recentis.—6 of fresh Rind in 20 of Spirit. *Dose*, 1 to 2 fl.dr.

Aqua Aurantii Floris. — ORANGE-FLOWER WATER. Water distilled from the flowers of the Bitter Orange tree, Citrus vulgaris, and of the Sweet

Orange tree, Citrus Aurantium. Prepared mostly in France.

Characters.—Colourless or greenish; fragrant; bitter. *Impurity.*—Lead, derived from the vessels in which it is imported.

Composition.—Orange flowers yield a volatile oil, *oleum Neroli*, and a trace of a bitter principle. *Dose*, ½ to 1 fl.oz.

Preparation.

Syrupus Aurantii Floris.—1 in 9. *Dose*, ½ to 1 fl.dr.

ACTION AND USES.

Orange is at once an **aromatic and a bitter** substance, and combines the action of these two classes of remedies, as described under *Calumba* and *Caryophyllum* respectively. It is extensively used as a highly agreeable flavouring agent in cookery, pharmacy, and the manufacture of liqueurs; and in these several ways may be turned to account therapeutically. It is but feebly bitter.

Limonis Cortex.—LEMON PEEL. The outer part of the rind of the fresh fruit of Citrus Limonum. From southern Europe.

Characters.—Thin pieces, pale yellow and rough on the outer surface from the presence of glands containing volatile oil; having little of the white spongy part of the rind. Odour fragrant; taste warm, aromatic, and bitter.

Composition.—Lemon Peel contains the official *volatile oil*, *Oleum Limonis*, $C_{10}H_{16}$, and a bitter principle, *hesperidin*.

Preparations.

1. **Syrupus Limonis.**—2, with 20 of Lemon Juice, in 41. *Dose*, 1 fl.dr.
2. **Tinctura Limonis.**—1 in 8 of *Proof* Spirit. *Dose*, ½ to 2 fl.dr.

From Lemon Peel is made:

Oleum Limonis.—The oil expressed from fresh Lemon Peel. Pale yellow; fragrant; warm, and bitter. Sp. gr. 0·85. *Dose*, 1 to 4 min.

Lemon Peel is also contained in Infusum Aurantii Compositum and Infusum Gentianæ Compositum; *Syrup of Lemon in* Liquor Magnesii Citratis; *Oil of Lemon in* Linimentum Potassii Iodidi cum Sapono and Spiritus Ammoniæ Aromaticus.

ACTION AND USES.

The action and uses of Lemon Peel are the same as those of Orange, the only difference being in the flavour.

Limonis Succus.—LEMON JUICE. The freshly expressed juice of the ripe fruit of Citrus Limonum.

Characters.—A slightly turbid yellowish liquor, with a grateful odour and sharp acid taste. Half a fluid ounce (one tablespoonful) contains about 20 gr. of Citric Acid, and neutralises $28\frac{1}{2}$ gr. of Bicarbonate of Potassium, 24 gr. of Bicarbonate of Sodium, or 15 gr. nearly of Carbonate of Ammonium.

Composition.—Lemon Juice contains *citric acid*, $H_3C_6H_5O_7$, both free and combined with *potassium* and other bases; *malic acid*, $H_3C_4H_3O_5$, and *phosphoric acid*, etc. *Dose*, $\frac{1}{2}$ to 4 fl.oz.

Preparations.

1. **Syrupus Limonis.**—See *Limonis Cortex.*
2. **Acidum Citricum.**—See *Acids*, page 142.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Lemon Juice in the mouth and stomach has the same action as Citric Acid, and is used chiefly to **relieve thirst and produce effervescing mixtures and drinks.**

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION AND USES.

Lemon Juice enters the blood as alkaline citrates, potassium salts, and phosphoric acid. Here the citrates are in part oxydised into carbonic acid and water. (See *Acidum Citricum.*) The potassium and phosphoric acid probably act upon the red corpuscles, of which they are both important constituents.

Lemon Juice is used with great success in the prevention and **treatment of scurvy**, a disease the exact nature of which is still obscure, but which is no doubt produced by the want of the juices of fresh vegetable and animal food. The Citric Acid, the Potash, and the Phosphoric Acid have severally been credited with the beneficial effect by different authorities. Lemon Juice has also been given in acute rheumatism and gout, but appears to be useful only in as far as it conveys alkalies into the blood and tissues.

3. REMOTE LOCAL ACTION AND USES.

These, which are of great interest, are fully described under Citric Acid, page 142.

Belæ Fructus.—BAEL FRUIT. The dried half-ripe fruit of Ægle Marmelos. From Malabar and Coromandel.

Characters.—Fruit roundish, about the size of a large orange, with hard woody rind; usually imported in dried slices, or in fragments consisting of portions of the rind and adherent dried pulp and seeds. Rind about $\frac{1}{8}$ inch thick, with a smooth pale-brown or greyish epicarp; pulp firm, brittle, brownish or cherry-red. The moistened pulp is mucilaginous.

Composition.—Bael has not been thoroughly analysed.

Preparation.

Extractum Belæ Liquidum.—1 in $1\frac{1}{16}$. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

In the fresh state Indian Bael is a pleasant refreshing fruit, with **astringent and refrigerant** properties, which render it valuable in the treatment of diarrhœa and dysentery. As imported it is probably useless; but a liquid extract from the *fresh* fruit appears to produce its specific effects. It is seldom employed out of India.

BYTTNERIACEÆ.

Oleum Theobromatis.—OIL OF THEOBROMA. Cacao Butter. A concrete oil obtained by expression and heat from the ground seeds of Theobroma Cacao, a small tree, a native of Demerara and Mexico.

Characters.—Of the consistency of tallow; yellowish; odour like that of chocolate; taste bland and agreeable; fracture clean. Does not become rancid from exposure to the air. Melts at 86° to 95° Fahr.

Composition.—Oil of Theobroma constitutes from 30 to 50 per cent. of the Cacao Bean, with an alkaloid *theobromine*, $C_7H_8N_4O_2$. It consists chiefly of stearin with a little olein.

Preparations.

Suppositoria Acidi Tannici, Hydrargyri, Iodoformi, Morphinæ, and Plumbi Composita.

ACTION AND USES.

Cacao Butter serves as a vehicle for more active substances in the form of suppositories. The action of Theobromine is the same as that of Caffeine. *See* page 301.

CAMELLIACEÆ.

Tea.—(*Not official.*) The dried leaves of Thea sinensis.

Composition.—Tea contains 1 to 4 per cent. of *caffeine*, $C_8H_{10}N_4O_2,H_2O$; a *volatile oil*, most abundant in green tea; and *tannin.* The relations of the alkaloid, as well as its

ACTION AND USES,

are described fully under *Caffeina*, page 301.

GUTTIFERÆ.

Cambogia.—GAMBOGE. A gum-resin obtained from Garcinia Hanburii. Imported from Siam.

Characters.—Cylindrical pieces, breaking easily with a smooth conchoidal glistening fracture; tawny, changing to brilliant yellow when rubbed with water: inodorous; taste acrid. *Impurity.*—Starch; yielding a green colour with iodine.

Composition.—Gamboge contains about 73 per cent. of a resinous substance *gambogic acid*, $C_{20}H_{23}O_4$; 25 per cent. of *gum;* and about 2 per cent. of water. Gambogic acid is insoluble in water, gives the brilliant yellow colour to the gum-resin, and forms salts with bases. It is less active than the gum-resin. *Dose*, 1 to 4 gr.

Preparation.

Pilula Cambogiæ Composita.—Gamboge, 1; Barbadoes Aloes, 1; Compound Powder of Cinnamon, 1; Hard Soap, 2; Syrup, q.s. *Dose*, 5 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Gamboge is an **irritant** to the stomach and bowels, causing vomiting in large doses, and in medicinal doses acting as a **hydragogue cathartic** not unlike Colocynth, without being cholagogue. It is seldom prescribed alone, and not often as the Compound Pill. Such a remedy is indicated in dropsies, cerebral hyperæmia, and as an anthelmintic (not to children); but other substances have now almost completely displaced it.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

Gambogic acid is chiefly thrown out in the liquid fæces; but part is absorbed, passes through the blood and tissues, and is excreted by the kidneys, which it stimulates, causing an increased flow of yellow-coloured urine. The **diuretic** effect may add to the value of the drug in dropsy.

CANELLACEÆ.

Canellæ Albæ Cortex.—CANELLA BARK. The bark of Canella alba, deprived of its corky layer and dried. From the West Indies.

Characters.—In quills or broken pieces; hard; buff or pale orange externally, paler internally. Odour aromatic, clove-like; taste acrid, pungent, and bitter.

Composition.—Canella contains a *bitter principle* and an *aromatic oil.*

Canella Alba is contained in Vinum Rhei. 60 gr. to 1 pint.

ACTION AND USES.

Canella Alba is an **aromatic bitter**, stomachic, and tonic, like Cascarilla. See *Calumbæ Radix*, and *Caryophyllum.*

VITACEÆ.

Uvæ.—RAISINS. The ripe fruit of Vitis vinifera, the Grape Vine, dried in the sun, or partly with artificial heat. Imported from Spain.

Composition.—Raisins contain *grape sugar*, *acid tartrate of potassium*, other vegetable acids, etc.

Raisins are contained in Tinctura Cardamomi Composita and Tinctura Sennæ.

ACTION AND USES.

Raisins are **demulcent**, refreshing, and nutrient, and are employed in medicine as **sweetening** and flavouring agents.

ZYGOPHYLLACEÆ.

Guaiaci Lignum.—GUAIACUM WOOD. "LIGNUM VITÆ." The heart-wood of Guaiacum officinale;

or of Guaiacum sanctum. Imported from the West Indies; and reduced to the form of chips, raspings, or shavings.

Characters.—Chips, raspings, or shavings, dark greenish-brown; taste acrid and somewhat aromatic; odour, when rubbed or heated, faintly aromatic.

Guaiaci Lignum is an ingredient of Decoctum Sarsæ Compositum, ¼ oz. to 1 pint.

Guaiaci Resina. — GUAIACUM RESIN. The resin obtained from the stem of Guaiacum officinale or of Guaiacum sanctum, by natural exudation, by incision, or by heat.

Characters.—Large masses, brownish or greenish-brown, covered with a green powder. Breaks with a clean glassy fracture. Odour somewhat balsamic; leaves an acrid sensation in the throat. A solution in spirit strikes a clear blue when applied to the inner surface of a raw potato (fresh protoplasm).

Substances resembling Guaiacum Resin: Myrrh, Scammony, Benzoin, Aloes, Resin; which have no green tinge.

Composition.—The chief constituent of Guaiacum Wood is the official *resin*, with a crystalline bitter colouring matter, gum, etc. The resin is itself composed of three resins: *guaiaconic acid*, $C_{19}H_{20}O_5$, 70 per cent.; *guaiac acid*, $C_6H_8O_3$, resembling benzoic acid; and *guaiaretic acid*, $C_{20}H_{26}O_4$, 10 per cent. *Incompatibles.*—Mineral acids, spirit of nitrous ether. *Dose of the Resin*, 10 to 30 gr.

Preparations.

1. **Mistura Guaiaci.**—Guaiacum Resin, 2; Sugar, 2; Gum Acacia, 1; Cinnamon Water, 80. *Dose*, ½ to 2 fl.oz.
2. **Tinctura Guaiaci Ammoniata.**—1 in 5 of Aromatic Spirit of Ammonia. *Dose*, ½ to 1 fl.dr., with 1 dr. of mucilage or yolk of egg, to form an emulsion.
3. **Pilula Hydrargyri Subchloridi Composita.**—1 in 2½. *See* page 93.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Internally, Guaiacum is a **local stimulant**, producing salivation, an acrid hot sensation in the throat, warmth in the epigastrium, increase of the movements and secretions of the stomach and bowels, and reflex stimulation of the heart. In large quantity it is a gastro-intestinal irritant, causing vomiting and purging, and the attendant disturbances of the system.

Guaiacum powder frequently relieves sore throat, if given in 30-gr. doses, to be placed on the tongue, and slowly swallowed every six hours. The Tincture or a non-official Lozenge is less successful. Plummer's Pill doubtless owes part of its mildly purgative effect to the Guaiac Resin it contains.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

The further action of Guaiacum physiologically is still obscure. Besides its **stimulant effect on the circulation** already mentioned, it appears to increase the secretions of the skin and kidney, and probably **stimulates the liver** and metabolism generally. In the form of the Ammoniated Tincture it is used in chronic gout and rheumatism, certainly with much success in some cases. As a constituent of Decoctum Sarsæ Compositum, not alone, it is given as an **alterative** in syphilis.

RUTACEÆ.

Buchu Folia. — BUCHU LEAVES. The dried leaves of: 1, Barosma betulina; 2, Barosma crenulata; 3, Barosma serratifolia. From the Cape of Good Hope.

Characters.—Smooth, dull yellowish-green, marked with oil glands on the margins, and especially on the under surface; having a powerful odour, and an aromatic, bitterish, mint-like taste. 1. The leaf of Barosma betulina is about ¾ inch long, coriaceous, obovate, serrate-dentate, with a recurved blunt apex. 2. The leaf of Barosma crenulata is about 1 inch long, oval, oblong, obtuse, minutely crenated, narrowed at base into a distinct petiole. 3. The leaf of Barosma serratifolia is 1 to 1½ inches long, linear-lanceolate, tapering equally to each end, sharply and closely serrated; texture thin. *Impurity.*—Leaves of *Emplanum serrulatum* (for those of Barosma serratifolia); have no glands. *Substances resembling Buchu:* Senna and Uva Ursi, which have entire leaves.

Composition.—Buchu contains a yellowish-brown *volatile oil*, in the glands or "dots," consisting of a crystalline stearoptene dissolved in a liquid hydrocarbon; and a bitter substance. *Dose*, 20 to 40 gr.

Preparations.

1. **Infusum Buchu.**—1 in 20. *Dose*, 1 to 4 fl.oz.
2. **Tinctura Buchu.**—1 in 8 of *Proof* Spirit. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

The action and uses of Buchu closely resemble those of Pareira, to the description of which the student is referred. It is more frequently employed than Pareira, its Infusion constituting an excellent vehicle for saline diuretics.

Oleum Rutæ.—OIL OF RUE. The oil distilled from the fresh herb of Ruta graveolens.

Characters.—Colour pale yellow; odour disagreeablo; taste bitter, acrid.

Composition.—Oil of Rue is a mixture of various *volatile oils*. *Dose*, 1 to 4 min.

ACTION AND USES.

The action and uses of Rue are the same as those of Savin, but it is seldom employed. See *Sabinæ Cacumina*, page 385.

Cuspariæ Cortex.—CUSPARIA BARK. Angustura Bark. The bark of Galipea Cusparia. From tropical South America.

Characters.—Flattish or curved pieces, or in quills, 6 inches or less in length; *obliquely cut* on inner edge. Coatod externally with a yellowish-grey mottled corky layer, which may be scraped off, exposing a dark brown resinous layer; inner surface light brown, flaky, sometimes with pieces of wood attached. Fracture short and resinous, exhibiting, under a lens, numerous white points or lines. Odour musty, disagreeable; taste bitter, aromatic. *Impurity.*—The bark of Strychnos Nux-vomica ("false angustura bark"); distinguished by its inner surface giving an arterial blood-red colour with HNO_3 (brucine); whilst true Cusparia Bark does not. *Cusparia resembles* Canella Alba, but is darker and has pared edges.

Composition.—Cusparia contains a crystalline bitter alkaloid, *cusparine* or *angusturine*, a second bitter substance, an *aromatic oil*, but no tannin. *Dose*, 10 to 40 gr.

Preparation.

Infusum Cuspariæ.—1 to 20 of Water at 120° Fahr. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Cusparia belongs to the group of **aromatic bitters**, the action and uses of which are fully discussed under *Calumba* and *Caryophyllum*. Like other bitters, it has been credited with **antipyretic and antiperiodic** properties, and in its native place is used instead of Cinchona for malarial diseases.

Jaborandi. — JABORANDI. Pilocarpi Foliola. The dried leaflets of Pilocarpus pennatifolius. From Brazil.

Characters.—Leaflets very shortly stalked, usually 4 inches or more long, oval-oblong; somewhat unequal at the base; obtuse and emarginate; slightly revolute and entire at the margins; coriaceous. Upper surface glabrous except when young, dull green; under surface paler, often somewhat hairy, with prominent midrib and pellucid dots. Odour when bruised slightly aromatic; taste slightly bitter and aromatic at first, subsequently pungent, increasing the flow of saliva. *Impurities.* —Leaves of species of Piper; not oval-oblong.

Composition.—Jaborandi contains *pilocarpine*, $C_{11}H_{16}N_2O_2$, a liquid colourless alkaloid, to which its chief effects are due. It also yields a second (isomeric) alkaloid, *jaborine*, closely resembling atropine in its action, and antagonistic to pilocarpine; as well as *pilocarpidine* and *jaboridine*, acting respectively like pilocarpine and jaborine, and probably oxydation products of these. *Dose*, 5 to 60 gr.

Preparations.

1. **Extractum Jaborandi.**—Alcoholic and aqueous. *Dose*, 2 to 10 gr.
2. **Infusum Jaborandi.**—1 in 20. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Jaborandi.**—1 in 4 of *Proof* Spirit. *Dose*, ½ to 1 fl.dr.

From Jaborandi is made:

Pilocarpinæ Nitras.—Nitrate of Pilocarpine, $C_{11}H_{16}N_2O_2, HNO_3$.

Source.—Made from Extract of Jaborandi by shaking it with Chloroform and an alkali; evaporating the solution; neutralising the product with Nitric Acid; and purifying by recrystallisation.

Characters.—A white crystalline powder or acicular crystals. *Solubility.*—1 in 8 or 9 of water; freely in hot rectified spirit. Strong Sulphuric Acid forms with it a yellowish solution, which, on the addition of

Bichromate of Potassium, gradually acquires an emerald green colour. *Dose*, $\frac{1}{20}$ to $\frac{1}{2}$ gr. by the mouth, $\frac{1}{10}$ to $\frac{1}{3}$ gr. hypodermically.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Jaborandi applied to the conjunctiva causes **contraction of the pupil** by stimulation of the ends of the third nerve, spasm of the apparatus of accommodation, and disturbance of vision. The effect commences in ten minutes, and lasts from 1½ to 24 hours before finally disappearing. It is used in some cases of inflammation of the eye, such as iritis; in certain forms of blindness; and in paralysis of the muscles.

Internally, in full doses, it is liable to cause nausea, vomiting, and increased peristalsis from direct action on the ganglia.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Pilocarpine enters the blood rapidly, and passes thence into the tissues. The striking effects of Jaborandi consist in **profuse salivation, perspiration, disturbance of vision, and circulatory depression**, which last for hours, and leave a sense of drowsiness and debility behind them.

Salivation is due to stimulation of the terminal ends of the chorda tympani in the glands, as well as of its centre. The flow commences in about five minutes after a moderate dose, and may last several hours. It increases with the dose. It is completely prevented or arrested by Atropine.

Perspiration is referable to stimulation both of the sudoriparous nerves and the sweat centres. It follows quickly on the appearance of the salivation; is accompanied by flushing of the skin, and sometimes rigor; progresses from the head downwards; may be so profuse as to soak the bed clothes; and lasts several hours. The body weight necessarily falls, metabolism is stimulated, and urea is said to be excreted in the saliva and sweat. Atropine arrests this diaphoresis. It is doubtful whether the milk be increased. The hair grows more actively under a course of Jaborandi. Bronchial and nasal secretions flow more freely; even the tears, cerumen, and alimentary secretions are somewhat increased; but not tho bile. The amount of urine is moderately raised at first by small doses; necessarily diminished if profuse sweating have occurred. The menses are not affected. The eye is affected specifically, as it is locally. Respiration is not modified directly by Pilocarpine. At first the heart and pulse are accelerated, but they are afterwards slowed and weakened; the vessels dilate; the blood pressure falls temporarily, then rises, and finally falls. Part of these effects is due to the action of the drug on the vagus in the heart, and can be arrested by Atropine; part to the ganglia. The temperature rises before, and falls during, the sweating.

Pilocarpine has been tried in every kind of disease, but is now chiefly given as a powerful and rapid diaphoretic. It is of most service in renal disease, especially with uræmia, eliminating both water and urea. It is less useful in effusions into the pleura and peritoneum. In cardiac dropsy, and, indeed, in every class of case, it must be used with caution if the heart be weak. It has also been given in syphilis, and in a variety of uterine conditions, with various results. Bronchial catarrh, asthma, and pertussis are all relieved by the flux which it establishes. Small doses relieve the thirst of chronic Bright's disease. Very conflicting reports have been published of its value in diphtheria, where it is said to loosen or detach the false membrane. It has been given with success as an antidote to Atropine.

SIMARUBACEÆ.

Quassiæ Lignum.—QUASSIA WOOD. The chips, shavings, or raspings of the Wood of Picræna excelsa. From Jamaica.

Characters.—Billets varying in size, frequently as thick as a man's thigh. Wood dense, tough, yellowish-white. Chips, shavings, or raspings; inodorous, intensely and purely bitter.

Substance resembling Quassia: Sassafras, which is aromatic, not bitter.

Composition.—The active principle of Quassia is *quassin*, $C_{32}H_{44}O_{10}$, a white, crystalline, *neutral* bitter principle. Quassia contains *no tannin.*

Preparations.

1. **Extractum Quassiæ.**—Aqueous. 48 in 1. *Dose*, 3 to 5 gr.
2. **Infusum Quassiæ.**—1 in 80 of *cold* Water. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Quassiæ.**—1 in 27 of *Proof* Spirit. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Quassia is a pure or simple bitter, and possesses the various properties fully described under *Calumbæ Radix*. It is very extensively used. The special points to be noted respecting it are: (1) that its preparations contain no tannin, and may be combined with salts of Iron; (2) that it is entirely devoid of flavour, and intensely bitter, *i.e.* less agreeable than Gentian and Chiretta; and (3) that the Infusion is an excellent anthelmintic enema.

CELASTRACEÆ.

Euonymus.—WAHOO. (*Not official.*) The bark of Euonymus atropurpureus.

Characters. — Quilled or curved pieces; ash-grey with blackish patches without; whitish within; nearly inodorous; sweetish, somewhat bitter, and acrid.

Composition.—Euonymus contains an intensely bitter *resin* and a *fixed oil.*

Non-official Preparations.

EXTRACTUM EUONYMI (U. S. P.).—*Dose,* 1 to 5 gr.

Euonymin.—A very variable eclectic preparation, consisting of the resin and fixed oil. *Dose,* 1 to 5 gr.

ACTION AND USES.

Euonymin is an **hepatic stimulant, direct cholagogue, and cathartic**; the latter effect being moderate unless other purgatives be combined. It is used in constipation and hepatic derangements.

RHAMNACEÆ.

Rhamni Frangulæ Cortex.—FRANGULA BARK. The dried bark of Rhamnus Frangula. Collected from the young trunk and moderate-sized branches, and kept at least one year before being used. Imported from Holland.

Characters.—Small quills, the bark itself being very thin, covered with a greyish-brown or blackish-brown corky layer, marked with transverse whitish lenticels; smooth, brownish-yellow within. Fracture short and purplish externally; somewhat fibrous and yellowish within. No marked odour; taste pleasant, sweetish, slightly bitter.

Composition.—Frangula contains a glucoside, *frangulin,* yielding *emodin,* $C_{15}H_{10}O_5$, also found in Rheum (q.v.).

Preparations.

1. **Extractum Rhamni Frangulæ.** — Alcoholic and aqueous. *Dose,* 15 to 60 gr.
2. **Extractum Rhamni Frangulæ Liquidum.**—1 in 1. *Dose,* 1 to 4 fl.dr.

ACTION AND USES.

Rhamnus Frangula is a certain and pleasant aperient, without griping or severe cathartic action, used in chronic constipation, and especially suitable for children.

Rhamni Purshianæ Cortex.—SACRED BARK. CASCARA SAGRADA. The dried bark of Rhamnus Purshiana. From the North Pacific Coast.

Characters.—Quills or incurved pieces, the bark itself being from $\frac{1}{25}$ to $\frac{1}{8}$ inch thick; smooth externally, covered with a greyish-white layer, frequently marked with lichens. Beneath the surface and internally it is brownish, nearly smooth, and striated longitudinally. Fracture short, except internally, where it is fibrous. No marked odour; taste bitter.

Composition.—A crystalline neutral principle and various resinoid bodies have been obtained from Cascara.

Preparations.

1. **Extractum Cascaræ Sagradæ.**—Alcoholic and aqueous. *Dose*, 2 to 8 gr.
2. **Extractum Cascaræ Sagradæ Liquidum.**—1 in 1. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

Cascara Sagrada is **tonic and stomachic** in small doses, aperient in large doses, and cathartic if freely given. It is useful in the same class of cases as the Rhamnus Frangula, but is more active and certain. The Liquid Extract may be given in a single full dose in the morning, or in divided doses of 10 to 15 min. thrice a day, before meals.

ANACARDIACEÆ.

Mastiche.—MASTICH. A concrete resinous exudation obtained by incision from the bark of the stem and large branches of Pistacia Lentiscus. From Scio.

Characters.—Small irregular yellowish tears, generally glassy, brittle, becoming ductile when chewed; odour balsamic, taste resinous. *Substance resembling Mastich:* Acacia; larger, rougher, and more opaque.

Composition.—Mastich consists of 80 or 90 per cent. of a resin, *mastichic acid*, $C_{20}H_{31}O_2$, soluble in alcohol; of a smaller quantity of another resin, *masticin*, $C_{20}H_{31}O$, soluble in ether, but insoluble in alcohol; and of a trace of volatile oil.

ACTION AND USES.

Mastich was formerly used much like other oleo-resins, but its application is now confined to dentistry, where it is employed as a **temporary stopping for carious teeth**. A solution in ether or collodion is applied on cotton wool with oil of cloves, and remains as a firm plug by evaporation of the solvent.

AMYRIDACEÆ.

Myrrha.—MYRRH. A gum-resinous exudation from the stem of Balsamodendron Myrrha. Collected in Arabia Felix and Abyssinia.

Characters.—In irregular-shaped tears or masses varying much in size, reddish-yellow or reddish-brown; brittle, the fractured surface irregular and somewhat oily; odour agreeable, aromatic; taste aromatic, acrid, bitter.

Composition.—Myrrh contains *gum*, 60 per cent.; a *volatile oil*, $C_{10}H_{11}O$, *myrrhol*, 2 per cent.; and a *resin*, *myrrhin*, 35 per cent. *Impurities.*—Every variety of resin and gum-resin; detected by appearance, smell, and taste. *Dose*, 10 to 30 gr.

Preparations.

1. **Pilula Aloes et Myrrhæ.**—1 in 5. See *Aloe Socotrina.*
2. **Tinctura Myrrhæ.**—1 in 8. *Dose*, ½ to 1 fl.dr.

Myrrh is also contained in Decoctum Aloes Compositum, Mistura Ferri Composita, Pilula Asafœtidæ Composita, and Pilula Rhei Composita.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Myrrh is a **stimulant and disinfectant** like other oleo-resins, and is sometimes used as a dressing for ulcers.

Internally.—It exerts a similar effect upon the mouth, throat, stomach and bowels. It is much employed as a wash (2 fl.dr. of the Tincture to 4 fl.oz. of water) in spongy gums and ulcerated mouth; as a gargle in relaxed throat; and as a **stomachic and adjuvant of purgatives** in dyspepsia, anæmia, and constipation.

2. ACTION ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

Myrrh **increases the number of leucocytes** in the blood, apparently by stimulating lacteal activity, and this fact may in part account for its value along with Iron in anæmia. Nothing definite is known of its specific action. Like the oleo-resins (see *Terebinthinæ Oleum*), Myrrh appears to be excreted by the mucous membranes, especially the genito-urinary and respiratory tracts, and stimulates them during its passage. It is thus an **uterine stimulant and emmenagogue**, and is extensively given along with Aloes or Iron in the amenorrhœa of girls. As a **stimulant and disinfectant expectorant** it is used less than formerly in chronic bronchitis.

Elemi.—MANILA ELEMI. A concrete resinous exudation, the botanical source of which is probably Canarium commune. Imported from Manila.

Characters.—A soft unctuous adhesive mass; becoming harder, more resinous, and yellowish by age; odour strong, fragrant, fennel-like; moistened with rectified spirit, it breaks up into small particles consisting microscopically of acicular crystals. *Substances resembling Elemi:* Asafœtida, Galbanum, Ammoniacum; known by smell.

Composition.—Elemi is a mixture of a *terpene* and 80 per cent. of *resinous bodies.*

Preparation.

Unguentum Elemi.—1 to 4 of Simple Ointment.

ACTION AND USES.

Elemi acts like Resin of Turpentine, and the Ointment is employed as a **stimulant and disinfectant.**

LEGUMINOSÆ.

Tragacantha.—TRAGACANTH. A gummy exudation, obtained from incisions in the stem of Astragalus gummifer, and some other species. Collected in Asia Minor.

Characters.—White or yellowish flakes, curved and ridged, somewhat translucent, tough and elastic, but rendered more pulverisable by a heat of 120° Fahr. Inodorous; nearly tasteless. Very sparingly soluble in cold water; but swells into a gelatinous mass, which is tinged violet by tincture of iodine. *Impurities.*—Other gums. After maceration in cold water, the fluid portion is not precipitated by rectified spirit. *Substance resembling Tragacanth:* Scilla, which is thicker and opaque.

Composition.—Tragacanth consists of two gums: *bassorin*, $C_{12}H_{20}O_{10}$, 33 per cent., comparatively insoluble in water, and unfermentable; and a gum nearly identical with the *arabin* of acacia (but precipitated by acetate of lead), 53 per cent., soluble in water. It also contains a little starch.

Preparations.

1. **Glycerinum Tragacanthæ.**—3; Glycerine, 12; Water, 2.
2. **Mucilago Tragacanthæ.**—1 in 80 of Water, *with the aid of Rectified Spirit.*
3. **Pulvis Tragacanthæ Compositus.**—Tragacanth, 1; Gum Acacia, 1; Starch, 1; Sugar, 3. *Dose*, 20 to 60 gr.

Tragacanth is also contained in Pulvis Opii Compositus, Confectio Opii, and Confectio Sulphuris.

ACTION AND USES.

Internally, Tragacanth is **demulcent**. The Mucilage may be used as a vehicle for more active substances in linctuses for pharyngeal cough. Tragacanth is partly converted into sugar by the stomach; in large quantities it causes indigestion. It is chiefly employed to suspend resins and heavy powders such as Bismuth, the simple gum being preferable to the Compound Powder, because less likely to ferment.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Tragacanth, like other gums, enters the blood and tissues, partly unchanged, partly as sugar and other products, and has a nutritive effect of comparatively low value. It is not used for this purpose. A remote demulcent effect on the urinary organs is probably imaginary only.

Glycyrrhizæ Radix.—LIQUORICE ROOT. The root and subterranean stems or stolons, fresh and dried, of Glycyrrhiza glabra. Cultivated in England.

Characters.—In long cylindrical pieces, smooth when fresh, furrowed when dried; pliable; yellowish-brown or reddish externally, yellow and juicy internally; with sickly earthy odour, sweet and mucilaginous when fresh, slightly acrid when dried. *Substances resembling Liquorice Root:* Pyrethrum and Taraxacum, which are not sweet.

Composition.—Liquorice Root contains *grape-sugar, glycyrrhizin, starch, resin, asparagin,* and *malic acid.* Glycyrrhizin is a yellow amorphous glucoside, $C_{24}H_{36}O_9$, with a strong bitter-sweet taste and acid reaction, yielding glucose and a very bitter substance, *glycyrretin.*

Preparations.

1. **Extractum Glycyrrhizæ.**—Aqueous. *Dose,* 5 gr. to 1 dr.
2. **Extractum Glycyrrhizæ Liquidum.**—Aqueous, with $\frac{1}{6}$ Spirit. *Dose,* 1 fl.dr.
3. **Pulvis Glycyrrhizæ Compositus.** — Senna, 2; Liquorice Root, 2; Fennel, 1; Sublimed Sulphur, 1; Sugar, 6. *Dose,* 30 to 60 gr.

Liquorice or its preparations are contained in many preparations throughout the Pharmacopœia. It especially covers the taste of Senna, Aloes, Chloride of Ammonium, Senega, Hyoscyamus, Turpentine, and Bitter Sulphates. The powdered root is a useful basis for pills.

ACTION AND USES.

Liquorice is chiefly used for the **pharmaceutical purposes** just indicated. It has a pleasant taste, and increases the flow of saliva and mucus when slowly chewed or sucked. It is a popular **demulcent,** used to relieve sore throat and coughs.

Scoparii Cacumina.—Broom Tops. The fresh and dried tops of Cytisus scoparius. Indigenous.

Characters. — Straight, angular, branched, dark-green, smooth, tough twigs; of a bitter nauseous taste; odour when bruised peculiar.

Composition.—Scoparium contains two active principles, *scoparin* and *sparteine,* besides other constituents. Scoparin, $C_{21}H_{22}O_{10}$, is a yellow crystalline neutral body, said by some to be a diuretic, by others not so. Sparteine, $C_{15}H_{26}N$, is a volatile, oily-looking liquid alkaloid, allied in appearance, composition, and action to conine. See *Conii Fructus,* page 280.

Preparations.

1. **Decoctum Scoparii.**—1, *dried,* in 20. *Dose,* 2 to 4 fl.oz.
2. **Succus Scoparii.**—3 of juice of *fresh* tops to 1 of Rectified Spirit. *Dose,* 1 to 2 fl.dr.

ACTION AND USES.

The action of Broom on the system is still obscure, the only fact definitely known being that it frequently produces free diuresis. It is believed that the active principles of the plant, either or both, pass through the blood and tissues, and stimulate the secreting structures of the kidneys during the process of excretion. Broom is therefore extensively used in this country as a **diuretic** in dropsy, especially cardiac dropsy, but is almost invariably combined with other drugs of the same class, such as Digitalis and Acetate of Potassium. It should be avoided in acute renal dropsy.

Pterocarpi Lignum.—RED SANDAL WOOD. The sliced or rasped heart-wood of Pterocarpus santalinus. From Ceylon.

Characters.—Dense heavy billets; externally dark brown, internally deep blood-red, variegated with lighter red zones, if cut transversely. Chips deep reddish-brown, of a faint peculiar odour, and slightly astringent taste. *Substance resembling Sandal Wood:* Logwood; less dense. (*See* page 262.)

Composition.—Red Sandal Wood contains a blood-red crystalline resinoid principle, *santalic acid* or *santalin*, $C_{14}H_{12}O_4$, insoluble in water.

USE.

Red Sandal Wood is used only to **give colour** to the Compound Tincture of Lavender.

Kino.—KINO. The juice obtained from incisions made in the trunk of Pterocarpus Marsupium, inspissated without artificial heat. From Malabar.

Characters.—In small, angular, glistening, reddish-black, brittle fragments, translucent and ruby-red at the edges; inodorous; very astringent, tinging the saliva blood-red. Partly soluble in water; soluble in spirit.

Composition.—Kino contains 75 per cent. of *kino-tannic acid*, $C_{18}H_{18}O_8$, giving a greenish precipitate with persalts of iron; *brenzcatechin*, a derivate of catechin (see *Catechu Pallidum*, page 300); *kino-red*, formed from kino-tannic acid by oxydation; and *gum*. *Incompatibles.*—Mineral acids, alkalies, and carbonates, metallic salts, and gelatine. *Dose*, 10 to 30 gr.

Preparations.

1. **Pulvis Kino Compositus.**—Kino, 15; Opium, 1; Cinnamon, 4. 1 of Opium in 20. *Dose*, 5 to 20 gr.

2. **Tinctura Kino.**—Kino, 2; Glycerine, 3; Water, 5; Rectified Spirit, to make 1 pint. *Dose*, ½ to 2 fl.dr.

Kino is also a constituent of Pulvis Catechu Compositus, 1 in 5.

ACTION AND USES.

Kino closely resembles Tannic Acid in its action, and may be used for the same purposes. (*See* page 371.) It is chiefly employed in the form of **astringent** gargles, and as a constituent of mixtures for diarrhœa.

Balsamum Peruvianum.—BALSAM OF PERU.

A balsam exuded from the trunk of Myroxylon Pereiræ, after the bark has been beaten, scorched, and removed. From Salvador in Central America.

Characters.—A reddish-brown or nearly black liquid, translucent in thin films; having the consistence of syrup, a balsamic odour, and an acrid taste. Insoluble in water; soluble in chloroform or rectified spirit.

Composition.—Balsam of Peru is a complex substance. The greater part consists of (1) the *volatile oil of Peruvian balsam*, which is itself composed of cinnamin (cinnamate of benzyl), $C_7H_7,C_9H_7O_2$; styracin (cinnamate of cinnamyl), $C_{18}H_{16}O_2$; peruvin (benzyl-alcohol), C_7H_7HO; benzoate of benzyl, $C_7H_7,C_7H_5O_2$; and styrone (cinnamic alcohol), C_9H_9HO; (2) *cinnamic acid* and *benzoic acid* ($HC_7H_5O_2$) in small quantities; and (3) a mixture of *resins*, probably hydrates of cinnamin. *Dose*, 10 to 15 min., made into an emulsion with mucilage.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Balsam of Peru possesses the properties of its several constituents, Benzoic Acid and its allies and resins, being an **antiseptic and disinfectant**, a **vascular and nutritive stimulant, and a nervine sedative.** (See *Terebinthinæ Oleum* for a full account.) Balsams have been used from time immemorial as applications to wounds and sores, but are now almost entirely displaced by simpler dressings, such as Carbolic Acid and Boric Acid. They are still used, however, to cleanse bed-sores. A more important application of Peruvian Balsam is in certain diseases of the skin, namely, (1) in some chronic inflammatory affections (eczema); (2) to **relieve itching** (prurigo, urticaria, etc.); and (3) in scabies, for which it is an excellent remedy, **killing the acarus**, relieving the itching and inflammation, and disinfecting the parts. The entire skin should be thoroughly rubbed with it (1 dr. to 1 oz. of Soft Paraffin) on two or more occasions; a warm bath being taken before, and the application washed off in the morning with Soft Soap.

Internally.—Balsam of Peru has a mild carminative effect on the stomach and bowels, like volatile oils.

2. ACTION ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

The important changes undergone in the blood and tissues by benzoic and cinnamic acids, and the excretion of these and of aromatic oils by the mucous membranes, kidneys, and skin, are fully discussed under *Benzoinum*, *Styrax*, and *Terebinthinæ Oleum*. The constituents of Peruvian Balsam appear chiefly to affect the respiratory organs; and it may therefore be added to cough mixtures as an agreeable **stimulant and disinfectant expectorant** in chronic bronchitis.

Balsamum Tolutanum.—BALSAM OF TOLU. A balsam which exudes from the trunk of Myroxylon Toluifera after incisions have been made in the bark. From New Granada.

Characters.—A reddish-yellow, soft and tenacious solid, becoming hard by keeping. It presents microscopical crystals of cinnamic acid. Odour highly fragrant; taste somewhat aromatic and acid. Soluble in spirit, with an acid reaction.

Composition.—Balsam of Tolu contains a *terpene*, $C_{10}H_{16}$, *tolene; benzoic and cinnamic acids;* and various *resins*. *Dose*, 10 to 20 gr., as an emulsion.

Preparations.

1. **Syrupus Tolutanus.**—1 in 29. *Dose*, 1 to 2 fl.dr.
2. **Tinctura Tolutana.**—1 in 8 of Spirit. *Dose*, 15 to 30 min.

Balsam of Tolu is also a constituent of Tinctura Benzoini Composita, and Pilula Phosphori; *Tincture of Tolu of* Trochisci Acidi Tannici, Morphinæ, Morphinæ et Ipecacuanhæ, and Opii.

ACTION AND USES.

These are the **same as those of Peruvian Balsam**, but Tolu is used internally only, and chiefly as a pleasant ingredient of cough mixtures.

Physostigmatis Semen.—CALABAR BEAN. The dried seed of Physostigma venenosum. Western Africa.

Characters.—From about 1 to 1¼ inch long, ¾ inch broad, and ½ inch thick; oblong and somewhat reniform, with a long broad blackish furrow along its convex side. Testa hard, brittle, roughish, deep chocolate-brown or brownish-red, enclosing a closely adhering nucleus, which principally consists of two hard white brittle cotyledons separated by a cavity. Inodorous; with no marked taste beyond that of an ordinary bean. It yields its virtues to alcohol, and imperfectly to water. The cotyledons moistened with solution of potash acquire a permanent pale yellow colour.

Composition.—Besides the ordinary constituents of beans, the Seed of Physostigma contains two alkaloids, (1) *physostigmine* or *eserine*, $C_{15}H_{21}N_3O_2$, combining with acids, and variously obtained as colourless crystals, or an amorphous or syrupy body; and (2) *calabarine*, usually mixed with commercial Eserine. *Dose, in powder,* 1 to 4 gr.

Preparation.

Extractum Physostigmatis.—Spirituous. 45 in 1. *Dose,* $\frac{1}{16}$ to ¼ gr.

From Physostigmatis Semen is made:

Physostigmina.—Physostigmine, Eserine, $C_{15}H_{21}N_3O_2$.

Source.—Made from the Alcoholic Extract of Calabar Bean, by dissolving it in water; adding Bicarbonate of Sodium; shaking the mixture with ether; and evaporating the ethereal liquid.

Characters.—Pinkish crystals, slightly soluble in water, but readily soluble in alcohol and in diluted acids. Aqueous solution alkaline, becomes red when warmed or shaken with dilute solution of potash.

Preparation.

LAMELLÆ PHYSOSTIGMINÆ.—Discs of Gelatine, with some Glycerine, each weighing about $\frac{1}{50}$ gr., and containing $\frac{1}{1000}$ gr. of Physostigmine.

Sulphate and Salicylate of Eserine (*non-official*) are also used.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Extract of Physostigma or preparations of Eserine are readily absorbed by the conjunctiva, and produce the specific contraction of the pupil to be presently noticed.

Taken by the mouth, Calabar Bean in moderate doses sometimes causes sickness and colic, and in larger doses diarrhœa, all from increased and irregular peristalsis, apparently of local origin. The Extract is therefore occasionally used in habitual constipation.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Eserine enters the blood unchanged, and passes thence into all the tissues. Along with the gastro-intestinal symptoms just described, moderate doses of the Bean give rise to a sense of weakness, faintness, and shortness of breath; larger doses to an aggravation of the same symptoms, with contraction of the pupil, frontal headache, salivation, diaphoresis, slowing and weakening of the pulse. These are short of poisonous effects.

On analysis it is found that consciousness is not lost, though impaired by large doses, showing comparative freedom of the *convolutions.* The *cord* is the part principally affected by Calabar Bean, the chief symptoms being of the nature of motor paralysis from **depression of the anterior cornua**, and thus of reflex irritability also. (*Calabarine* has a *stimulant* effect on the cord, but otherwise agrees in action with Eserine.) The respiratory muscles necessarily fail from this cause. The posterior cornua (sensory portions) of the cord are paralysed to a degree, so that sensibility is diminished in the limbs. The *motor nerves* and *muscles* are but slightly affected directly. Occasional twitchings occur, partly, at least, direct in origin. The *sensory nerves* are not directly influenced.

The *medulla* is decidedly affected by Physostigma. Thus **the respiratory centre**, after brief (probably reflex) stimulation, **is depressed**, and death occurs chiefly by asphyxia. The cardiac centre is first stimulated, so that the heart beats more powerfully and less frequently; but at last, or after large doses, depression ensues. Therewith the intracardiac branches of the vagus are probably stimulated at first, and the ganglia paralysed at last. The blood pressure rises with the increased cardiac action, and falls later on. Whether there be any direct action of Eserine on the vaso-motor apparatus is unsettled.

Contraction of the pupil and spasm of accommodation are striking and highly important effects of Eserine, whether it be given internally or applied locally. Both phenomena are due to **irritation of the fibres of the third nerve**, and not to central disturbance as in the contraction caused by Opium, nor to paralysis of the sympathetic. They are accompanied by **fall of the intraocular tension**, and can be removed by Atropine.

The salivary secretion is increased through the centre of the chorda, but ceases after large doses from arrest of the circulation in the glands.

The specific *uses* of Calabar Bean depend on its action on the cord and the eye. It has been frequently given in tetanus, and other convulsive diseases referable to irritation or disease of the spinal centres, and apparently with success, although many of these cases recover spontaneously, and others resist the Eserine. The alkaloid should be given subcutaneously in doses of gr. $\frac{1}{60}$ to $\frac{1}{12}$ or more in solution; or gr. $\frac{1}{3}$ of the Extract, rubbed up with spirit, gum, and water, may be given subcutaneously, or gr. 1 by the mouth, repeated in two hours, and followed by doses of gr. $\frac{1}{16}$ to $\frac{1}{4}$ every few hours. For the convulsions of Strychnine poisoning Calabar Bean is of little or no use. Neither is it of much real service in the treatment of poisoning by Atropine or Chloral, as was once expected.

In diseases of the eye Eserine is now much used. A drop of a solution of the non-official sulphate (2 gr. to 1 fl.oz. of water) is applied locally to diminish intraocular pressure in glaucoma, perforating keratitis, etc.; in paralysis of the iris and ciliary muscle, *e.g.* after diphtheria ($\frac{1}{2}$ gr. to 1 fl.oz.); to counteract the effects of Atropine; or to diminish the entrance of light in painful diseases of the eye, photophobia, etc. The Lamellæ, inserted beneath the lids, are a convenient form for ophthalmic purposes.

3. REMOTE LOCAL ACTION.

Eserine is excreted by the liver and salivary glands, but has never been found in the urine.

Chrysarobinum.—CHRYSAROBIN. GOA POWDER. The medullary matter of the stem and branches of Andira araroba, dried and powdered; containing and yielding chrysophan, which is rapidly oxydised into chrysophanic acid.

Characters.—As purified by solvents it is a light brownish-yellow, minutely crystalline powder, tasteless, inodorous. Very sparingly soluble in water; almost entirely so in 150 parts of hot spirit.

Composition.—Chrysarobin, $C_{30}H_{26}O_7$, is converted into *chrysophanic acid*, $C_{10}H_8O_3$, by slow oxydation, or by solution in strong potash and decomposition with a mineral acid. Chrysophanic acid is also contained in Rhubarb. (See *Rhei Radix*, page 349.) *Dose*, $\frac{1}{6}$ to $\frac{1}{2}$ gr.

Preparation.

Unguentum Chrysarobini.—1 to 24 of Benzoated Lard.

ACTION AND USES.

Externally.—Chrysarobin **destroys low vegetable organisms in connection with the skin,** stains it purple-red, and **stimulates** it so much as to produce in some instances serious constitutional disturbance. It is a successful application in some forms of ringworm, and in scaly and other diseases of the skin, especially psoriasis.

Internally, it is apt to cause vomiting and purging. It has been given with variable success in psoriasis and other cutaneous diseases, apparently from a remote local action on the skin. It is also excreted by the kidneys, and stains the urine yellow.

Senna Alexandrina.—ALEXANDRIAN SENNA. The dried leaflets of Cassia acutifolia (Cassia lanceolata). From Alexandria.

Characters.—About $\frac{3}{4}$ to fully 1 inch long, lanceolate or oval-lanceolate, acute, *unequal at the base,* entire, thin, brittle, pale yellowish-green; veined on the lower surface; nearly smooth. Odour peculiar, faint, tea-like; taste mucilaginous, nauseous, sickly. *Impurities, and substances resembling Senna:* Solenostemma Argel, Uva Ursi, and Barosma, all equal at the base.

Senna Indica.—EAST INDIAN OR TINNIVELLY SENNA. The dried leaflets of Cassia angustifolia (Cassia elongata). From Southern India.

Characters.—About 1 to 2 inches in length, lanceolate, acute, *unequal at the base,* thin, entire; yellowish-green and smooth above, somewhat duller beneath; glabrous or slightly pubescent. In odour and taste similar to Alexandrian Senna.

Composition.—Senna contains an active principle, *cathartic acid;* a colouring matter closely allied to *chrysophanic acid;* a peculiar unfermentable sugar, *catharto-mannite;* other obscure glucosides, *sennapicrin* and *sennacrol;* and various vegetable salts. Cathartic acid, a highly important body, is an amorphous glucoside, $C_{180}H_{192}N_{82}SO_2$, which forms salts with bases, and can be broken up into glucose and cathartogenic acid. *Dose,* 10 to 30 gr. in powder.

Preparations of either kind of Senna.

1. **Confectio Sennæ.**—Senna, 7; Coriander Fruit, 3; Figs, 12; Tamarind, 9; Cassia Pulp, 9; Prune, 6; Liquorice, 1; Sugar, 30; Water *q.s.* to make 75. *Dose*, 60 to 120 gr.
2. **Infusum Sennæ.**—1 in 10, with $\frac{1}{10}$ Ginger. *Dose*, 1 to 2 fl.oz.

From Infusum Sennæ is prepared:

MISTURA SENNÆ COMPOSITA.—Infusion of Senna, 15; Tincture of Senna, 2½; Sulphate of Magnesium, 4; Liquid Extract of Liquorice, 1; Compound Tincture of Cardamoms, 1½. *Dose*, 1 to 1½ fl.oz.

3. **Syrupus Sennæ.**—Senna, 16 oz.; Oil of Coriander, 3 mins.; Sugar, 24 oz.; Water, 5 pints; Rectified Spirit, 3 fl.oz.; to make 42 oz. *Dose*, 1 to 4 fl.dr.
4. **Tinctura Sennæ.**—Senna, 2½ oz.; Raisins, 2 oz.; Caraway and Coriander, of each ½ oz.; *Proof* Spirit, 1 pint. *Dose*, 2 to 8 fl.dr.

Senna is also the most important ingredient in Pulvis Glycyrrhizæ Compositus. 2 in 12. (*See* page 253.)

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Given *internally*, Senna **stimulates the muscular coat of the intestine**, apparently by local reflex action originating in the mucous surface of the bowel itself; and produces brisk peristaltic movements and **purgation** within four or five hours. The colon is chiefly stimulated, hurrying downwards the fluid contents received from the ileum, which appear as very thin copious yellow stools, with excess of sodium salts and digestive products, but no special increase of bile. Full doses cause repeated evacuation and griping, but no inflammation of the mucous surface. The pelvic structures may, however, become hyperæmic, leading to hæmorrhoids and the appearance of the menses. Constipation does not follow the use of Senna.

Senna is never given alone, but always with a carminative to prevent griping, and frequently with other purgatives, as in the Compound Mixture. It is one of the most useful of purgatives. It is very extensively prescribed to complete the effect of mercurial and other duodenal purgatives, given several hours before. It affords at once a rapid and a safe purge at the commencement of febrile attacks in children, in local inflammations, and in cerebral congestion. As an habitual laxative in the form of Pulvis Glycyrrhizæ Compositus, Senna is most valuable, being a simple stimulant of the muscular coat, which neither loses its effect by use, nor produces subsequent constipation. Combined with bitter and other stomachics, it is useful in dyspepsia, the laxative effect of free cathartic acid naturally being increased by acids and diminished by alkalies.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Cathartic acid and chrysophanic acid enter the blood, pass through the tissues, and are excreted by the kidneys and mammary gland; the cathartic acid purging infants at the breast, the chrysophanic acid staining the urine yellow. Senna acts as a purgative in animals when injected into the veins.

Hæmatoxyli Lignum.—LOGWOOD. The sliced heart-wood of Hæmatoxylon campechianum. Imported from Campeachy, Honduras, and Jamaica.

Characters.—The logs are hard, heavy, externally blackish-red, internally reddish-brown. The chips are reddish-brown, have a feeble agreeable odour, and a sweetish astringent taste. A small portion chewed imparts to the saliva a dark reddish-pink. *Substance resembling Logwood:* Red Sandal Wood, which is more dense, odourless, and less astringent to taste.

Composition.—Logwood contains *tannic acid*, and a peculiar colouring principle, *hæmatoxylin*, $C_{16}H_{14}O_6$, occurring in colourless crystals, which become red on exposure to light; the solutions undergoing various changes of colour with acids and alkalies, and coagulating gelatine. The Decoction precipitates perchloride of iron violet-blue, acetate of lead and other metallic salts a beautiful blue. Other less important substances occur in logwood. *Incompatibles.*—Mineral acids, metallic salts, lime-water, and tartar-emetic.

Preparations.

1. **Decoctum Hæmatoxyli.**—1 in 20, with $\frac{1}{8}$ of Cinnamon. *Dose*, 1 to 2 fl.oz.
2. **Extractum Hæmatoxyli.**—Aqueous. *Dose*, 10 to 30 gr.

ACTION AND USES.

Hæmatoxylon possesses the **astringent** action of Tannic Acid, and may be used in the same class of cases. *See* page 371.

Cassiæ Pulpa—CASSIA PULP. The pulp obtained from the pods, recently imported, of Cassia

Fistula, the Purging Cassia. Imported from the East or West Indies.

Characters of the pods.—Cylindrical, 1½ to 2 feet long, shortly stalked, slightly curved, blackish-brown, pointed, very hard; indehiscent; divided by transverse septa into numerous cells, each containing a seed and viscid pulp. The *pulp* blackish-brown, viscid, with a sweetish disagreeable taste, somewhat sickly in odour; containing seeds and dissepiments.

Composition.—Cassia Pulp contains *sugar*, pectin, mucilage, and *a purgative principle* probably allied to *cathartic acid.* See *Senna*, page 260.

Cassiæ Pulpa is contained in Confectio Sennæ, about 1 in 8.

ACTION AND USES.

Cassia Pulp is a **laxative**, given only as Confectio Sennæ.

Tamarindus.—TAMARIND. The preserved pulp of the fruit of Tamarindus indica. Imported from the West Indies.

Characters.—A reddish-brown moist sugary mass, enclosing strong branched fibres, and brown shining seeds enclosed in a tough membranous coat. Taste agreeable, refreshing, subacid. *Impurity.*—Copper; a piece of bright iron left in the pulp for an hour should not exhibit any deposit of copper.

Composition.—Tamarind contains *sugar*, *gum*, *tartaric acid* and *tartrate of potassium*, *citric*, *acetic*, and various *aromatic acids.*

Tamarind is contained in Confectio Sennæ, 9 in 75.

ACTION AND USES.

Tamarind is a pleasant acid **refrigerant** and gentle **laxative**. For the former purpose it is prepared as an infusion, or as Tamarind Whey (1 part of the pulp to 30 parts warm milk), which is also a mild purgative, like the Confectio Sennæ.

Copaiba. — COPAIVA. The oleo-resin obtained by deeply cutting or boring into the trunk of Copaifera Langsdorffii, and other species of Copaifera. From the Valley of the Amazon, West and East Indies.

Characters.—A more or less viscid liquid; generally transparent, occasionally opalescent and slightly fluorescent; light yellow to pale golden brown; odour peculiar, aromatic; taste persistent, acrid, somewhat bitter. Sp. gr. 0·940 to 0·993. Insoluble in water; soluble in ether, alcohol, fixed and volatile oils, and benzol.

Composition.—Copaiva consists of less than 50 per cent. of the official *volatile oil*, and more than 50 per cent. of *resin*. Oil of Copaiva, isomeric with turpentine, $C_{10}H_{16}$, is colourless or pale yellow, with the odour and taste of Copaiva. Resin of Copaiva is a brownish resinous mass, consisting of a crystallisable resin, *copaivic acid*, $C_{10}H_{30}O_2$, the chief constituent of the oleo-resin, and a non-crystallisable *viscid resin of copaiva*, amounting to 1½ per cent. The proportion of oil and resin varies much with the age and exposure of the Copaiva. *Impurities.*—Turpentine; detected by the odour on heating. Fixed oils; leaving a greasy ring round the resinous stain when heated on paper. Copaiva dissolves ¼ its weight of carbonate of magnesium by the aid of heat, and remains transparent (copaivate of magnesium); fixed oils not so. Gurjun balsam, coagulating at 270°; Copaiva not so. *Dose*, ½ to 1 fl.dr.

From Copaiba is made:

Oleum Copaibæ.—The oil distilled from Copaiba. *Dose*, 5 to 20 min., with mucilage or yolk of egg.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Copaiva produces an acrid nauseous sensation in the mouth, warmth in the stomach, unpleasant eructations, and gastro-intestinal irritation like other oleo-resins. Large doses or the persistent use of the drug leads to dyspepsia, sickness, and diarrhœa; it is contra-indicated in irritable states of the stomach and bowels.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION AND USES.

The active principles of Copaiva are absorbed into the blood, and pass thence into the tissues. The action on the organs is obscure. The volatile oil is excreted by the kidneys, bronchi and skin, and the resin at least by the kidneys. All the secretions smell freely of the drug, and the neighbourhood of the patient is pervaded with a characteristic unpleasant odour. In thus passing through the eliminating organs, Copaiva stimulates them, altering their secretions and the nutrition of their cells and vessels. The urine is passed more frequently, and usually in increased quantity: but it may be scanty, with albumen and blood, pain in the loins, and other symptoms of renal congestion. The albumen thus passed must be distinguished from the acid resin of Copaiva which may be thrown down from the urine by nitric acid, and which is dissolved by heat or alcohol. Carried by the urine into the bladder and urethra, and possibly also excreted by the mucous membranes of the same parts, **Copaiva produces along the whole genito-urinary tract a stimulant and disinfectant effect.** A similar influence is produced in the bronchi; the mucous secretion is increased, and **expectoration reflexly excited.** The stimulation of the skin (and probably the primary gastro-intestinal irritation in part) may sometimes cause an eruption, the "Copaiva rash," not unlike that of measles.

The uses of Copaiva depend entirely on its remote local effects, the immediate local effects only suggesting care in its administration. Its chief application is to the genito-urinary organs. The resin is given as a highly useful **diuretic** in hepatic and cardiac dropsy, but must be avoided in the dropsy of Bright's disease. It is much to be preferred to the Oleo-resin for this purpose. The latter is chiefly employed in inflammatory affections of the bladder and urethra, especially gonorrhœa, when the first acute symptoms have somewhat subsided. Naturally it is less useful in vaginitis. Copaiva is now seldom used in bronchial affections, on account of the unpleasant effects attending it; but it will sometimes diminish and disinfect the profuse foul products of chronic bronchitis and bronchiectasis when other means have failed. It is occasionally given in skin diseases.

Acaciæ Gummi.—GUM ACACIA. A gummy exudation from the stem and branches of Acacia Senegal, and from other species of Acacia. Collected chiefly in Kordofan.

Characters and tests.—In spheroidal or vermicular tears or masses; colourless, or with a yellowish, brownish, or reddish tint; opaque from numerous minute cracks, and brittle, or in fragments with shining surfaces. Inodorous; bland and mucilaginous in taste. Insoluble in alcohol, but soluble in water. *Impurities.*—Starch. Gum resins; detected by smell and taste.

Composition.—Gum Acacia consists chiefly of *arabic acid*, or *arabin*, $C_6H_{10}O_{15}$, combined with calcium, magnesium, and potassium; and 17 per cent. of water. *Incompatibles.*—Alcohol and sulphuric acid. Borax, persalts of iron, and subacetate of lead render it gelatinous.

Preparations.

Mucilago Acaciæ.—Gum, 4; Water, 6. *Dose*, 1 to 4 fl.dr.

Gum Acacia is also contained in Mistura Cretæ, Mistura Guaiaci, Pulvis Amygdalæ Compositus, Pulvis Tragacanthæ Compositus, and in all Trochisci.

ACTION AND USES.

Acacia possesses very **similar** properties and physiological effects **to those of Tragacanth**, and is employed for the same purposes. (See *Tragacantha.*) An objection to its pharmaceutical use is its liability to undergo fermentation, and cause indigestion and diarrhœa. Its principal application therapeutically is for cough, in the form of lozenges and linctuses.

Indigo.—C_8H_5NO. (*Appendix B.P.*) A blue pigment prepared from various species of Indigofera.

Preparation.

Solution of Sulphate of Indigo. (*Appendix B.P.*) The colour is destroyed by free Chlorine. *Used* in testing.

Piscidiæ Erythrinæ Cortex. (*Not official.*)—The bark of the root of Piscidia erythrina, Jamaica Dogwood.

Characters.—Quills or flat pieces, ⅛ inch thick; externally light-brown, warty; internally dark-brown, fibrous; fracture short, greenish. Odour peculiar, strong, disagreeable; taste acrid, burning.

Composition.—Piscidia yields a crystalline alkaloid, *piscidine*, $C_{29}H_{24}O_8$.

Preparation.

EXTRACTUM PISCIDIÆ ERYTHRINÆ FLUIDUM.—(U. S. P.) *Dose*, 20 to 120 min.

ACTION AND USES.

Jamaica Dogwood acts first as a stimulant of the brain and spinal cord, causing a kind of intoxication and a tendency to spasms; and afterwards as a **hypnotic and sedative.** At the same time it stimulates the vaso-motor system, thus raising the blood pressure and slowing the heart. Death occurs by respiratory failure. It is also mydriatic, diaphoretic, and sialagogue.

Piscidia has been used as a hypnotic, instead of Opium, in the insomnia of alcoholism and insanity; and as an antispasmodic in asthma and chorea. Its value as an anodyne is more doubtful; but it has been given in neuralgia, sick-headache, and colic. The drug appears to be extremely uncertain.

ROSACEÆ.

Rosæ Gallicæ Petala.—RED ROSE PETALS. The fresh and dried unexpanded petals of Rosa gallica. From plants cultivated in Britain.

Characters.—Usually in little cone-like masses; colour fine purplish-red, retained after drying; odour roseate, developed by drying; taste bitterish, feebly acid, and astringent.

Composition.—Rose Petals contain an *aromatic volatile oil, tannic* and *gallic acids,* gum, colouring matters, salts, etc. *Oleum rosæ* exists in very small quantity; it consists of an aromatic elœoptene, $C_{10}H_{14}O$, and an odourless solid, rose-camphor, $C_{18}H_{16}$.

Preparations.

1. **Confectio Rosæ Gallicæ.**—1 of *fresh* Petals to 3 of Sugar. *Dose,* 30 to 60 gr.
2. **Infusum Rosæ Acidum.**—1 of *dried* Petals in ½ of Diluted Sulphuric Acid and 40 of Water. *Dose,* 1 to 2 fl.oz.
3. **Syrupus Rosæ Gallicæ.**—1, *dried,* in 17¼. *Dose,* 1 fl.dr.

Rosæ Centifoliæ Petala.—CABBAGE OR DAMASK ROSE PETALS. The fresh fully expanded petals of Rosa centifolia. From British plants.

Characters.—Large, thin, delicate. Odour very fragrant; taste sweetish, bitter, and faintly astringent; both readily imparted to water.

Preparation.

Aqua Rosæ.—1 in 1, by distillation. *Dose,* 1 to 2 fl.oz.
Aqua Rosæ is contained in Mistura Ferri Composita and Trochisci Bismuthi.

ACTION AND USES.

The preparations of the Red and the Cabbage Rose are chiefly used as pleasant vehicles. The Acid Infusion is an agreeable astringent.

Rosæ Caninæ Fructus.—FRUIT OF THE DOG ROSE; HIPS. The ripe fruit of Rosa canina, the Dog Rose, and other indigenous allied species.

Characters.—About an inch in length, ovoid, scarlet, smooth, shining; inodorous; taste sweet, subacid, pleasant.

Composition.—Hips contain *malic* and *citric acids*, free and combined; *tannic acid*, *sugar*, and a trace of *volatile oil.*

Preparation.

Confectio Rosæ Caninæ.—1 in 3, with Sugar.

ACTION AND USE.

The Confection of Hips forms a very useful **basis for pills.**

Amygdala Dulcis.—SWEET ALMOND. The ripe seed of the Sweet Almond tree, Prunus Amygdalus. *var.* dulcis. Imported from Malaga, and known as the Jordan Almond.

Characters.—Above an inch in length, nearly oblong, acute at one end, rounded at the other; compressed; with a scurfy brown coat. Taste bland, sweet, nutty. *Impurity.*—The bitter almond, which yields odour of HCN when bruised with water.

Amygdala Amara.—BITTER ALMOND. The ripe seed of the Bitter Almond tree, Prunus Amygdalus, *var.* amara. Brought chiefly from Mogadore.

Characters.—Resembles the Sweet Almond in appearance, but is broader and shorter, has a very bitter taste, and when rubbed with water emits an odour like ratafia.

Composition.—Both varieties of Almond yield by expression about 50 per cent. of *fixed* oil, Oleum Amygdalæ, and albuminous substances including *emulsin.* The bitter variety also yields, by distillation with water, a *volatile* oil, Oleum Amygdalæ Amaræ, Essential Oil of Bitter Almonds, C_6H_5COH, not official. The two oils must be carefully distinguished, inasmuch as the crude form of Bitter Almond Oil generally sold is highly poisonous, from admixture with 4 to 8 per cent. of hydrocyanic acid. Bitter Almonds contain neither tho volatile oil nor hydrocyanic acid until moistened, but 2 to 3 per cent. of *amygdalin*, $C_{20}H_{27}NO_{11}$, a crystalline glucoside, which, in the presence of water, and under the fermentative influence of the emulsin, breaks up into the volatile oil, hydrocyanic acid, and glucose: $C_{20}H_{27}NO_{11} + 2H_2O = C_6H_5COH + HCN + 2C_6H_{12}O_6$. When purified by separation of the hydrocyanic acid, Volatile Oil of Bitter Almonds is not poisonous, consisting, as it does, of hydride of benzol (C_7H_5OH), with benzoic acid ($C_7H_6O_2$) as a product of oxydation by exposure, and other allied substances; and is used for flavouring sweets. Nitrobenzene, however, artificial Oil of Bitter Almonds, or "Nitrobenzol," $C_6H_4(NO_2)H$, which is sometimes substituted for it, having a very similar flavour, is decidedly poisonous, and has caused death.

From either Sweet or Bitter Almond is made:

Oleum Amygdalæ.—Almond Oil. The oil *expressed* from the Sweet or Bitter Almond. Pale yellow, nearly inodorous, with a bland oleaginous nutty taste. *Dose*, 2 to 4 fl.dr.

Almond Oil is contained in Oleum Phosphoratum, Unguentum Cetacei, Unguentum Resinæ, Unguentum Simplex (and its preparations). It is used in preference to Olive Oil, as it makes a whiter ointment.

Preparations of the Sweet Almond.

Pulvis Amygdalæ Compositus.—8, to 4 of Sugar, and 1 of Gum Acacia. *Dose*, 60 to 120 gr.

From Pulvis Amygdalæ Compositus is prepared:

MISTURA AMYGDALÆ.—1; with Water, 8. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

The Sweet Almond is **demulcent and nutritive**, and has been ground into a flour for making cakes to be eaten by diabetic patients, instead of starchy food. The Compound Powder and Mixture are used only as vehicles for insoluble powders and demulcent cough medicines.

Almond Oil has the same action, and is used for the same purposes, as Olive Oil, which, though less agreeable, is generally employed as being cheaper. See *Oleum Olivæ*, page 314.

Prunum.—PRUNE. The dried drupe of Prunus domestica, the Plum. From the south of France.

Characters. — Ovoid or oblong; 1¼ inch long; black; shrivelled; pulp brownish, without marked odour; taste sweet, somewhat mucilaginous and acidulous.

Composition.—The prune contains *sugar*, *malic acid*, and a purgative principle.

Prunum is contained in Confectio Sennæ, 6 in 75.

ACTION AND USES.

The Prune is **nutritive, demulcent, and slightly laxative.** It may be ordered as an article of diet in habitual constipation.

Laurocerasi Folia.—CHERRY-LAUREL LEAVES. The fresh leaves of Prunus Laurocerasus.

Characters.—Thick, coriaceous, on strong short petioles; oblong or somewhat obovate; 5 to 7 inches long, tapering towards each end, recurved at apex; distantly but sharply serrated and slightly revolute at margins; dark-green, smooth, and shining above, much paler beneath; midrib prominent, on either side of which, towards the base, are 1 or 2 glandular depressions. On bruising, they emit a ratafia-like odour.

Composition.—Cherry Laurel Leaves yield by distillation a variable amount of *hydrocyanic acid* and a *volatile oil*, by a process of decomposition resembling that just described in the Bitter Almond. Neither emulsin nor ordinary amygdalin has, however, been demonstrated in the leaves, but a resinoid body, which yields with emulsin hydrocyanic acid, and is called "*amorphous amygdalin.*"

Preparation.

Aqua Laurocerasi.—1 in 1¼ by distillation, and the addition either of Water or of Hydrocyanic Acid to the distillate, so as to adjust the strength to 0·1 per cent. of Real Hydrocyanic Acid, as tested volumetrically with $AgNO_3$. *Incompatibles:* metallic salts. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

Cherry Laurel Water possesses the action of Diluted Hydrocyanic Acid, and is also a **flavouring agent.** (*See* page 184.)

Cusso.—KOUSSO. The dried panicles (chiefly of the female flowers) of Hagenia abyssinica. From Abyssinia.

Characters.—In compressed clusters or rolls, 10 inches or more long; or in small fragments; brownish or greenish-brown (female flowers reddish); odour herby, tea-like; taste bitter,

acrid, disagreeable. Separate panicles much branched, zigzag, covered with hairs and glands; a large sheathing bract at the base of every branch. Flowers numerous, small, shortly stalked, unisexual, the male brownish-yellow, the female tinged with red; with 2 roundish bracts at the base of each; calyx hairy, veiny, with 10 segments in 2 alternating whorls.

Composition.—Kousso contains a *volatile oil*, *tannic acid*, *gum*, *sugar*, and a neutral crystallisable active principle, *koussin* or *cossin*, $C_{31}H_{38}O_{10}$, soluble in alkaline solutions. *Dose*, ¼ to ½ oz.

Preparation.

Infusum Cusso.—¼ oz. in 4 oz. Boiling Water; to be drunk without straining, for one dose.

ACTION AND USES.

Taken in the large doses necessary, Kousso is apt to cause nausea, vomiting, colic, and slight diarrhœa. Its principal action is as an **anthelmintic**, the tape-worms (Tænia solium, Tænia mediocanellata, and Bothryocephalus latus) being readily killed by it. It is used for this purpose only, and rarely in England. It may or may not require the assistance of a purgative to expel the dead worm. The powdered flowers, either in compressed masses or suspended in an aromatic water, are said to be much more active than the official Infusion.

MYRTACEÆ.

Caryophyllum.—CLOVE. The dried flower-bud of Eugenia caryophyllata. From Penang, Bencoolen, and Amboyna.

Characters.—Over half an inch long, consisting of a dark-brown, wrinkled, subcylindrical, somewhat angular calyx tube, tapering below, and surmounted by 4 teeth, between which the paler-coloured petals, enclosing the stamens and style, are rolled up in the form of a ball. Odour strong, fragrant, spicy; taste very pungent, aromatic. Emits oil when indented.

Composition.—Cloves contain 20 per cent. of the official *oil*, tannic acid, and gum. Oil of Cloves consists of *eugenol* (eugenic acid), $C_{10}H_{12}O_2$, chemically resembling Phenol, and a terpene, $C_{15}H_{24}$. A crystalline body, *eugenin*, isomeric with eugenol; a neutral body, *caryophyllin*, isomeric with camphor; and a salicyl compound, can also be obtained from Cloves.

Preparations.

Infusum Caryophylli.—1 in 40. *Dose*, 1 to 4 fl.oz.

Caryophyllum is also contained in Infusum Aurantii Compositum, Mistura Ferri Aromatica, and Vinum Opii.

From Caryophyllum is made :

Oleum Caryophylli.—Oil of Cloves. The oil distilled in Britain from Cloves. Colourless when recent, becoming red-brown, with the odour and burning spicy taste of the Clove. It is one of the few volatile oils heavier than water. *Dose*, 1 to 4 min.

Oleum Caryophylli is contained in Confectio Scammonii, Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

Incompatibles.—Lime-water, salts of iron, mineral acids, and gelatine.

ACTION AND USES.

Cloves may be taken as the type of a great group of remedies, other members of which are Orange, Lemon, Pimento, Cajuput, Caraway, Dill, and many more, which are met with in our systematic review of medicinal plants. This group is known as the **Aromatic Volatile Oils**, of complex and variable chemical composition, as described at page 8. They are closely allied, on the one hand, to Phenol (Carbolic Acid) and Benzoic Acid; on the other hand to still more complex vegetable products, the Balsams and Gum-resins. Instead of dislocating the various members of the group of aromatic oils from their proper botanical position to discuss them together, we will describe their action and uses once for all under the present head, it being understood that what is said of Oil of Cloves applies to the other substances, with occasional qualifications.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Oil of Cloves and allied substances closely resemble Turpentine in their properties. Whilst **preventing or arresting decomposition**, they redden and inflame the skin, and cause for a time smarting pain, which gives place to local anæsthesia. Oil of Cloves and other fragrant oils are too costly to be used externally, except to scent liniments; but the concrete "oils," or solid constituents of the oils, of Peppermint, Thyme, Eucalyptus, Myrtle, etc. (stearoptenes), are excellent **antiseptics, local anæsthetics, stimulants and counter-irritants**, and Turpentine and Camphor are common applications for these purposes. Such aromatic substances might be used to disinfect foul wounds and ulcers, and promote healing; to hasten the removal of chronic inflammatory products by increasing the local blood flow, and thus to reduce swelling in or under the skin, the periosteum, or the joints ; to relieve neuralgic and rheumatic pains, such as sciatica and lumbago, by dulling the sensibility of the nerves; and to act reflexly on deeper parts (for instance, the lungs or heart), when applied to the skin over them as counter-irritants.

Internally.—In the *mouth* the aromatic Oils of Cloves and its allies act much as they do on the skin. Besides being antiseptic, they dilate the local vessels (? directly), and thus increase the circulation, heat, and nutrition, and may even cause inflammation. They irritate the nerves, causing pain associated with a sense of burning; but depression quickly follows, and local anæsthesia. Oil of Cloves is a valuable application in toothache from dental caries, acting at once as an anodyne and disinfectant. At the same time, the nerves of **taste and smell (flavour) are powerfully excited.** Several *reflex* results, of the first importance in digestion, follow these local changes, namely: (1) salivation; (2) a flow of mucus; (3) hyperæmia of the gastric mucosa, a sense of hunger, and a flow of gastric juice. Therewith there occur (4) stimulation of the appetite and increase of relish by the pleasing flavour. In a word, aromatics produce **an increased desire for, enjoyment of, and digestion of food.**

Aromatic Oils are accordingly used very extensively in cookery, where the proper use of them constitutes an important portion of the culinary art. Those of them which are also bitter, such as Orange, are taken with wines and spirits as various "aromatic bitters," liqueurs, etc., to rouse or strengthen appetite and digestion before or during a meal. In pharmacy they are employed to correct the tastes of nauseous drugs; and therapeutically they are given in dyspepsia and debility along with most bitters to increase the saliva and the gastric juice.

In the *stomach* the effect of Aromatics on the vessels and nerves is continued. Besides causing an increased flow of juice by stimulation of the mouth, these substances are powerful **stomachics** in several ways. The vessels of the mucosa are dilated ; the nerves of the same are first excited (causing a sense of heat in the epigastrium) and then soothed, thus relieving pain; the contents, if decomposing, as in dyspepsia, are partly disinfected. Their *reflex* influence is equally important. The muscular coat is stimulated, thus increasing the gastric movements, and the cardiac orifice is perhaps relaxed : Aromatics thus expelling flatulence, and relieving painful cramps, spasms, hiccup, and other forms of distress, an effect generally described as **carminative.** Distant organs are also reflexly stimulated: the vigour of the heart increased, the blood pressure raised, and the spinal, medullary, and even cerebral centres temporarily excited, to the relief of low, hysterical, and "spasmodic" symptoms, as well as of more serious conditions such as asthma, cardiac pain, and palpitation. Aromatics are thus **general stimulants and antispasmodics.**

In the *intestines* the Aromatic Oils may still be found partly unabsorbed, acting on the same structures as before, increasing the local circulation and secretions, stimulating the intestinal movements, and expelling flatus. They thus relieve or prevent pain or spasm (colic), and provide us with valuable **correctives** of the griping tendencies of many purgatives. The constitution of the most important compound pills, powders, and laxative draughts should be studied in this connection, such as Pilula Rhei Composita, Pulvis Jalapæ Compositus, and Mistura Sennæ Composita. Caryophyllum is slightly astringent, by virtue of its Tannic Acid.

2. ACTION IN THE BLOOD.

The Aromatic Oils of Cloves and its allies enter the blood as such, and whilst oxydised in part by the red corpuscles, leave the circulation mainly unchanged. Some of them are known to **increase the number of white corpuscles**, by the dilatation of the abdominal vessels just described, and consequent stimulation of the organs which supply the blood with leucocytes.

3. SPECIFIC ACTION AND USES.

The Aromatic Oils are rarely given in sufficient doses to produce definite specific effects on the tissues and organs. It may safely be assumed that in the main their action closely resembles that of Turpentine, or that of Camphor, respectively, according as the elæoptene or the stearoptene is in excess in the particular drug. (*See* pages 380 and 354.) Speaking generally, they are **stimulant and antispasmodic**; but let it be noted that a great part of this effect is reflex from the stomach, as has just been described.

4. REMOTE LOCAL ACTION AND USES.

The Aromatic Oils are excreted by the kidneys, skin, bronchi, liver, and probably the bowels, partly unchanged, partly as resins. In passing through these structures they **stimulate and disinfect** them. This subject is of the first importance in pharmacology, and will be best discussed under the head of Turpentine, an oil which produces very marked remote effects. (See *Terebinthinæ Oleum*, page 380.)

Pimenta.—PIMENTO. The dried unripe full grown fruit of Pimenta officinalis, the Allspice tree. From the West Indies.

Characters.—Dry, light, roundish, one-fifth of an inch or more in diameter, crowned with the remains of the calyx as a raised scar-like ring. Pericarp roughish from presence of oil glands; brittle, dark-brown, 2-celled, each cell containing a brownish-black compressed reniform seed. Odour and taste warm, aromatic, resembling Cloves. *Substances resembling Pimento:* Pepper, which has no calyx; Cubebs, which is stalked.

Composition.—Pimento contains chiefly the official *volatile oil*, chemically identical with oil of cloves.

Preparations.

Aqua Pimentæ.—1 in $11\frac{1}{2}$, by distillation. *Dose*, 1 to 2 fl.oz.

From Pimenta is made:

Oleum Pimentæ.—The oil distilled from the fruit in England. Colourless, becoming brown by keeping. Sp. gr. 1·02. Sinks in water. *Dose*, 1 to 4 min.

ACTION AND USES.

The action and uses of Pimento are the same as those of the preparations of Cloves and other **aromatics.**

Oleum Cajuputi.—OIL OF CAJUPUT. The oil distilled from the leaves of Melaleuca minor. Imported from Batavia and Singapore.

Characters. — Transparent, limpid, very volatile, pale bluish-green; odour strong, agreeable, camphoraceous; taste warm, bitterish, aromatic, camphoraceous, succeeded by a sensation of coldness. Sp. gr. ·914.

Composition.—Oil of Cajuput consists of *hydrate of cajuputene* ($\frac{2}{3}$), isomeric with Borneo Camphor, $C_{10}H_{16},H_2O$, and a second oil ($\frac{1}{3}$), boiling at a higher temperature. *Impurities.*—Copper; detected by usual tests. Other volatile oils. *Dose*, 1 to 4 min.

Preparation.

Spiritus Cajuputi.—1 to 49 of Spirit. *Dose*, 30 to 60 min.

Oil of Cajuput is also contained in Linimentum Crotonis.

ACTION AND USES.

Cajuput Oil resembles in its action and uses Oil of Cloves. It is used externally, as a **stimulant and counter-irritant.**

Oleum Eucalypti.—OIL OF EUCALYPTUS. Eucalyptol. The oil distilled from the fresh leaves of Eucalyptus globulus; Eucalyptus amygdalina; and probably other species of Eucalyptus, the Gum Tree. From Australia.

Characters.—Colourless or pale straw, becoming darker and thicker by exposure. Odour aromatic; flavour spicy, pungent, leaving a sensation of coldness in the mouth. Neutral. Sp. gr. 0·900. Readily soluble in alcohol.

Composition.—Eucalyptol consists of 70 per cent. of a terpene $C_{10}H_{16}$, with *cymene* $C_{10}H_{14}$, and an oxydised portion; also of an oil isomeric with hydrate of cajuputene. It readily changes into a resin, yielding ozone. *Dose,* 1 to 4 min.

Preparation.

Unguentum Eucalypti.—1 in 5 with Hard and Soft Paraffin.

Eucalyptus Gauze (non-official) is also prepared.

ACTION AND USES.

Externally.—Eucalyptus Oil is a powerful **antiseptic and disinfectant.** The Gauze for a time almost supplanted Carbolic Acid Gauze in Lister's process, as being neither irritant locally nor poisonous when absorbed, but it is now seldom used.

Internally.—The action of Eucalyptus Oil is nearly the same as that of Oil of Turpentine, with which it is otherwise so closely allied. (*See* page 378.) It is **antipyretic and antiperiodic** to a degree, like Quinine, and was once believed to be of value in ague. The Blue Gum tree is planted in aguish districts to free the soil from malaria. The Oil has been given with benefit in typhoid fever, septicæmia, and pneumonia.

The remote local action of Eucalyptus is important. It leaves the system by the kidneys and lungs, giving its odour to their excretions, and disinfecting these and the mucous surfaces. The Oil is therefore indicated, on the one hand, in pyelitis and cystitis; and, on the other hand, in bronchitis, dilated bronchi, and asthma.

Granati Radicis Cortex.—POMEGRANATE ROOT BARK. The dried bark of the root of Punica Granatum. Obtained from the South of Europe.

Characters.—Small quills or fragments, 2 to 4 inches long; externally yellowish-grey, wrinkled or cracked with faint longitudinal striæ, or furrowed with corky bands; internally nearly smooth, yellow; fracture short; no odour; taste astringent, feebly bitter.

Composition. — Pomegranate Root Bark contains *tannin;* a colourless oily volatile alkaloidal body *pelletierine;* also a substance resembling mannite (*see* page 318), mucilage, etc. *Incompatibles:* Alkalies, lime-water, metallic salts, gelatine.

Preparation.

Decoctum Granati Radicis.—1 in 10. *Dose,* 2 to 4 fl.oz.

ACTION AND USES.

Pomegranate Root Bark has an **anthelmintic** and slightly irritant action, much like Kousso, but is somewhat **astringent** unless taken in large quantities. It is used in the treatment of tape-worm, which is expelled (not actually killed) by the Decoction, preceded and followed by a purgative.

DIPTEROCARPINEÆ.

Chaulmugra Oil. (*Not official.*)—The oil expressed from the seeds of Gynocardia odorata. India.

Characters.—A pale-brownish unctuous solid, with a disagreeable smell and taste.

Composition.—Chaulmugra Oil contains a quantity of *palmitic acid,* with three other fatty acids, including *gynocardic acid,* the supposed active principle. *Dose,* 2 to 15 gr., in milk or emulsion.

ACTION AND USES.

Chaulmugra Oil is believed to be **a local stimulant and nutritive,** when administered either by inunction or internally. It was for a time much praised in leprosy, and has also been used for phthisis, lupus, psoriasis, and chronic rheumatism.

CUCURBITACEÆ.

Colocynthidis Pulpa.—Colocynth Pulp. The dried peeled fruit, freed from seeds, of Citrullus Colocynthis. Imported chiefly from Smyrna, Trieste, France, and Spain.

Characters.—Whitish balls, about 2 inches in diameter, very light, spongy; consisting of pulp with embedded seeds.

Broken-up pulp, alone official, is light, spongy, white or yellowish-white, inodorous, intensely bitter. *Impurities.*—Seeds and cortex, ground up with the pulp.

Composition.—The active principles of Colocynth are a bitter glucoside *colocynthin*, $C_{56}H_{84}O_{23}$, usually amorphous, but crystallisable, readily soluble in water and alcohol; and *citrullin*, a resinoid powder, insoluble in water. *Dose*, 2 to 8 gr.

Preparations.

1. **Extractum Colocynthidis Compositum.**—Colocynth Pulp, 6; Extract of Socotrine Aloes, 12; Resin of Scammony, 4; Curd Soap, 3; Cardamom Seeds, 1; Proof Spirit, 160. *Dose*, 2 to 5 gr.
2. **Pilula Colocynthidis Composita.**—Colocynth Pulp, 1; Barbadoes Aloes, 2; Resin of Scammony, 2; Sulphate of Potassium, $\frac{1}{4}$; Oil of Cloves, $\frac{1}{4}$; Water, q.s. (about $\frac{1}{4}$). *Dose*, 5 to 10 gr.

From Pilula Colocynthidis Composita is made:

PILULA COLOCYNTHIDIS ET HYOSCYAMI.—2; Extract of Hyoscyamus, 1. *Dose*, 5 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Colocynth is a powerful **gastro-intestinal stimulant** or irritant, according to the amount given, causing speedy large and watery evacuations of the bowels, attended by griping and general depression unless its effect be covered by a carminative. It is one of the most powerful of official purgatives, acting as a **hydragogue cathartic**, as well as on the muscular coat and intestinal glands and liver, the secretions of which are rendered abundant and watery.

Colocynth is always used in combination with milder purgatives and carminatives. The Compound Pill is extensively employed alone, or with Calomel or Blue Pill, as an occasional purgative, to produce free evacuation of the bowels, and relieve the portal system, after free living, in bilious derangement, or in chronic constipation. It is less suitable as a habitual purgative. Its hydragogue effect is employed in cerebral congestion, where rapid "derivation" is required; and in dropsies, especially ascites, either alone or as the basis of a pill containing Elaterin. Colocynth must be given with caution in pregnancy, and entirely avoided in delicate or irritable conditions of the stomach and bowels.

2. ACTION IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTION.

Colocynthin enters the blood, and is excreted partly by the kidneys, being, according to some, a diuretic.

Ecballii Fructus.—SQUIRTING CUCUMBER FRUIT. The fruit very nearly ripe of Ecballium Elaterium. From plants cultivated in Britain.

From Ecballii Fructus is made:

Elaterium.—A sediment from the juice of the Squirting Cucumber Fruit. Made by pressing the juice from the incised fruit, straining, decanting, and drying the sediment on tiles.

Characters.—In flattened or slightly incurved pieces, about 1 line thick; light greenish-grey; friable; odour faint, tea-like; taste bitter and acrid (but not to be tasted by the student). *Impurities.*—Starch, flour, and chalk.

Composition. — Elaterium contains the official active *neutral* principle, *elaterin.* *Dose,* $\frac{1}{16}$ to $\frac{1}{2}$ gr.

From Elaterium is made:

Elaterinum.—Elaterin, $C_{20}H_{28}O_5$. The active principle of Elaterium.

Source.—Made by exhausting Elaterium with chloroform, adding ether to the solution, washing the resulting precipitate with ether, and purifying by recrystallisation from chloroform.

Characters and tests.—Small colourless bitter crystals; insoluble in water, sparingly soluble in spirit. With melted carbolic acid it yields a solution which, with H_2SO_4, becomes first crimson and then rapidly scarlet. *Dose,* $\frac{1}{40}$ to $\frac{1}{10}$ gr.

Preparation.

Pulvis Elaterini Compositus.—1 to 39 of Sugar of Milk. *Dose,* $\frac{1}{2}$ to 5 gr.

ACTION AND USES.

Elaterin acts much like Colocynth, as a **gastro-intestinal irritant**, but is decidedly more violent, being the most powerful hydragogue purgative which we possess. It produces, even in doses of $\frac{1}{12}$ to $\frac{1}{6}$ gr., numerous very watery motions, with griping and considerable depression.

Elaterin is used almost entirely as a **hydragogue purgative** in dropsies and uræmia, relieving the venous pressure by free evacuation of fluid into the bowel. More rarely it is given as a rapid "derivative" in cerebral cases; and still more rarely as an evacuant in obstinate constipation. This drug must be used with caution, and must not be ordered in catarrhal states of the stomach or bowels.

UMBELLIFERÆ.

Conii Folia.—HEMLOCK LEAVES. The fresh leaves and young branches of Conium maculatum; gathered from wild British plants when the fruit begins to form.

Characters.—Pinnately divided, the lower leaves decompound and sometimes 2 feet long; glabrous; arising from a smooth stem marked with dark purple spots, by clasping petioles, those of the lower leaves hollow. Odour strong and very disagreeable, especially when rubbed with solution of potash. *Dose, in powder*, 2 to 8 gr.

Conii Fructus.—HEMLOCK FRUIT. The fruit of Conium maculatum, gathered when fully developed, but while still green, and carefully dried.

Characters.—About $\frac{1}{8}$ inch long, broadly ovoid, compressed laterally, crowned by the depressed stylopod; dull greenish-grey. Consists usually of the separated mericarps, each presenting 5 prominent crenated ridges, with the furrows smooth, and without evident vittæ. Powdered and rubbed with solution of potash, it yields a very strong disagreeable odour.

Substances resembling Conium Fruit: Caraway, Anise, Dill; known by presence of vittæ.

Composition.—The active principle of Conium is a yellowish liquid alkaloid, *conine*, $C_8H_{16}HN$. It is strongly alkaline, oily, and volatile; with a peculiar disagreeable mouse-like odour; nearly insoluble in water. It is readily disengaged from the preparations of the plant by the addition of alkalies; and is liable both to conversion into an inert resinous mass by exposure, and to decomposition by heat. The preparations of Conium, for these and probably other reasons, are peculiarly uncertain in strength and action. *Coniic acid*, *methyl-conine*, $C_8H_{14}CH_3N$, a colourless fluid, and *conhydrine*, $C_8H_{17}NO$, crystalline, also exist in Hemlock. *Incompatibles.*—Caustic alkalies, vegetable acids, and astringents.

Preparations.

A. *Of Conii Folia:*

1. **Extractum Conii.**—A *green* extract. 30 in 1. *Dose*, 2 to 6 gr.

From Extractum Conii is prepared:

PILULA CONII COMPOSITA.—Extract of Hemlock, 5; Ipecacuanha, 1; Treacle, q.s. *Dose*, 5 to 10 gr.

2. **Succus Conii.**—3 of the expressed juice, with 1 of Spirit. *Dose*, 30 to 60 min.

From Succus Conii are prepared:

a. CATAPLASMA CONII.—Juice, 1, evaporated to ½; Linseed Meal, 4; Boiling Water, 10.
b. VAPOR CONINÆ.—Juice, ½ fl.oz.; Solution of Potash, 1 fl.dr.; Water, 1 fl.oz. *Dose*, 20 min., put on the sponge of an inhaler containing hot water.

B. *Of Conii Fructus:*

Tinctura Conii.—1 in 8 of *Proof* Spirit. *Dose*, 20 to 60 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied as the Cataplasm, Conium has long been esteemed an **anæsthetic**, and been used to relieve the pain of cancer, as well as to promote the absorption of tumours. Careful experiment fails to confirm this opinion, the whole of the sensory nervous system remaining unaffected by the drug, unless indirectly by poisonous doses.

Internally.—Conium sometimes causes irritation and vomiting. The Extract is an adjuvant vehicle of purgative powders, such as Calomel.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Conine is readily absorbed into the blood; reaches the tissues; and is found unchanged in many of the organs after administration. Moderate doses cause a sense of weight in the legs and weakness of the knees; confusion of vision, with drooping of the upper lids, and swollen appearance of the eyes; giddiness; thickness of speech, and slight dysphagia. The poisonous effects of the plant are well described in the classical account of the death of Socrates.

On analysis, the action of Conium is found to be as follows: The **motor nerves** are the parts specially attacked by Conium, being **paralysed from their extremities upwards**, whence the heaviness and weakness of the limbs. The muscles themselves remain irritable. The motor parts of the cord are but slightly affected, but their reflex excitability is moderately reduced. The **respiratory centre** in the medulla is **finally paralysed**; the cardiac and vascular centres are not definitely influenced. The convolutions remain intact until asphyxia supervenes. The corpora striata are possibly depressed. Death in Hemlock poisoning occurs by asphyxia, due to paralysis of the respiratory nerves and depression of the respiratory centre.

Conium, although of great interest to the pharmacologist, is but little used in medicine. It has been recommended, as large doses of the Succus, in spasmodic and convulsive diseases such as tetanus, chorea, and epilepsy; in mania with muscular excitement; and in asthma, pertussis, and spasmodic affections of the larynx. Vapor Coninæ would appear to afford relief in some of the last-named class of cases. Possibly the Compound Pill may allay spasmodic cough.

Conine is excreted unchanged, chiefly in the urine.

Asafœtida.—ASAFŒTIDA. A gum-resin obtained by incision from the living root of Ferula Narthex, of Ferula Scorodosma, and probably other species. From Afghanistan and the Punjab.

Characters.—Irregular masses, composed of tears agglutinated by a darker softer material. Broken or cut, the exposed surface is amygdaloid, the fractured tears opaque and milk-white at first, changing to purplish-pink, and finally to dull yellowish-brown. Rarely in tears. Taste bitter, acrid, alliaceous; odour strong, alliaceous, persistent. With water it forms a white emulsion. The freshly fractured surface of a tear, touched with nitric acid, assumes briefly a fine green colour. *Substances resembling Asafœtida:* Galbanum, Ammoniacum, Benzoin; known by odour.

Composition.—Asafœtida contains 5 per cent. of a *volatile oil*, 65 per cent. of *resin*, and 25 per cent. of *gum*. The oil is probably complex, but consists chiefly of sulphide of allyl $(C_3H_5)_2S$, essential oil of garlic, to which the unpleasant odour is due. The resin also contains sulphur. *Impurities.*—Earthy matter, detected by burning. *Dose*, 5 to 20 gr.

Preparations.

1. **Enema Asafœtidæ.**—30 gr. in 4 fl.oz. of Water.
2. **Pilula Aloes et Asafœtidæ.**—Equal parts of Socotrine Aloes, Asafœtida, Hard Soap, and Confection of Roses. *Dose*, 5 to 10 gr.

3. **Pilula Asafœtidæ Composita.**—Syn.: Pilula Galbani Composita. Asafœtida, 2; Galbanum, 2; Myrrh, 2; Treacle, 1. *Dose*, 5 to 10 gr.
4. **Spiritus Ammoniæ Fœtidus.**—Asafœtida, 1½; Strong Solution of Ammonia, 2; Spirit, to 20. *Dose*, ½ to 1 fl.dr.
5. **Tinctura Asafœtidæ.**—1 in 8. *Dose*, ½ to 1 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Asafœtida **possesses the action of other volatile oils and resins** upon the alimentary canal, but differs from them in this highly important respect, that whilst most of them are aromatic and pleasant to the palate, it is **extremely disagreeable.** The mental influence of this nauseous impression, added to the other stimulant effects on the mouth and stomach (see *Caryophyllum*, page 272), constitutes Asafœtida a powerful **nervine stimulant**, which arrests the emotional disturbance, muscular spasms, and other morbid nervous disorders of hysteria. It is no longer used in true epilepsy, chorea, laryngismus, or asthma. The **stimulant action** of volatile oils **on the bowel** (see *Terebinthinæ Oleum*, page 379), is specially marked, and is employed in the Enema Asafœtidæ to expel flatulence, relieve constipation, and arrest convulsions.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION AND USES.

The volatile oil of Asafœtida passes through the blood and tissues, and is excreted in the urine, sweat, breath, and discharge from wounds. Thus remotely it exerts the usual stimulant action of volatile oils, and is sometimes given as a **stimulant and disinfectant expectorant** in chronic bronchitis.

Galbanum.—GALBANUM. A gum-resin obtained from Ferula galbaniflua, Ferula rubricaulis, and probably other species. From India and the Levant.

Characters.—In tears, or in masses of agglutinated tears. *Tears* roundish or irregular, from the size of a lentil to a hazel nut, generally that of a pea; yellowish or orange-brown, or yellowish-green; translucent; rough and dirty on the surface; hard and brittle in cold weather, softening in the summer, and by the heat of the hand becoming ductile and sticky. The *masses* contain pieces of root, stem, and other impurities; are hard, yellowish-brown, rarely greenish. Odour peculiar, aromatic, not disagreeable; taste bitter, unpleasant, alliaceous. *Substances resembling Galbanum:* Ammoniacum, Asafœtida, Benzoin; known by odour.

Composition.—Galbanum contains 3 to 6 per cent. of a *volatile oil*, isomeric with turpentine, $C_{10}H_{16}$; 20 per cent. of *gum;* and 65 per cent. of *resins*, which yield by dry distillation a blue oil, and *umbelliferone*, $C_9H_6O_3$, in colourless, odourless needles.

Preparation.

Emplastrum Galbani.—Galbanum, 1; Ammoniacum, 1; Yellow Wax, 1; Lead Plaster, 8.

Galbanum is also an ingredient of Pilula Asafœtidæ Composita.

ACTION AND USES.

Galbanum acts and is used much **like Asafœtida** and Ammoniacum, and is always used with either of these substances, chiefly externally.

Ammoniacum.—AMMONIACUM. A gum-resinous exudation from the stem (after being punctured by beetles), of Dorema Ammoniacum. Collected in Persia and the Punjab.

Characters.—In roundish tears, from the size of a coriander fruit to a cherry; or in nodular masses of agglutinated tears; yellowish-brown externally when recent, darkening by keeping to cinnamon-brown; milky white and opaque internally; hard and brittle when cold, breaking with a dull waxy fracture, but readily softening with heat. Odour faint, peculiar, non-alliaceous; taste bitter, acrid. With water, it forms a nearly white emulsion. Coloured yellow by KHO; a solution of chlorinated soda gives it a bright orange hue. *Substances resembling Ammoniacum:* Asafœtida, Galbanum, Benzoin; known by odour.

Composition.—Ammoniacum contains about 4 per cent. of a *volatile oil*, 20 per cent. of gum, and 70 per cent. of *resin*, $C_{40}H_{50}O_9$. The oil does not contain sulphur. *Dose*, 10 to 20 gr.

Preparations.

1. **Emplastrum Ammoniaci cum Hydrargyro.**—Ammoniacum, 656; Mercury, 164; Olive Oil, 7; Sublimed Sulphur, 1.
2. **Mistura Ammoniaci.**—A milk-like emulsion. 1 in 32 of Water, added gradually with trituration. *Dose*, ½ to 1 fl.oz.

Ammoniacum is also an ingredient of Emplastrum Galbani, 1 in

11; Pilula Ipecacuanhæ cum Scillâ, 1 in 7; and Pilula Scillæ Composita, 1 in 6.

ACTION AND USES.

The action of Ammoniacum closely resembles that of the other aromatics and oleo-resins, but it is used almost solely for its remote local effects. Being excreted by the bronchial mucosa, it stimulates the surface and disinfects the secretions of the part (see *Terebinthinæ Oleum*); and it probably acts similarly on the skin. It is used as a **disinfectant expectorant** in chronic bronchitis with profuse discharge, and as a constituent of plasters intended to strengthen the circulation in the skin and promote absorption.

Anisi Fructus.—ANISE FRUIT. The dried fruit of Pimpinella Anisum.

Characters.—Anise fruits, with the exception of the Russian variety which is shorter, are about $\frac{1}{5}$ inch long; ovoid-oblong; greyish-brown; the whole surface covered with short hairs. The two mericarps united, with a common stalk, each with 5 pale slender entire ridges. Transverse section exhibits about 15 vittæ. Odour agreeable, aromatic; taste sweetish, spicy.

Composition.—The chief constituent is the official *oil.*

Preparation.

Aqua Anisi.—10 from 1, by distillation.

From Anisi Fructus is made:

Oleum Anisi.—OIL OF ANISE. The oil distilled in Europe from Anise Fruit; or in China from Star Anise Fruit (N.O. *Magnoliaceæ*, page 203).

Characters.—Colourless or pale yellow; with the odour of the fruit, and an aromatic sweetish taste. Ordinary Oil of Anise congeals between 50° and 60° F., and may remain solid at 62° F. Oil of Star Anise only becomes solid just above 32° F. Sp. gr. ·980.

Composition.—Oil of Aniseed is composed of two bodies, a terpene ($\frac{1}{5}$), and a stearoptene *anethol* ($\frac{4}{5}$), $C_{10}H_{12}O$, crystallising out at the above temperatures. *Dose*, 1 to 4 min

Preparation.

ESSENTIA ANISI.—1 to 4 of Spirit. *Dose*, 10 to 20 min.

Oil of Anise is also contained in Tinctura Camphoræ Composita, and Tinctura Opii Ammoniata.

ACTION AND USES.

The action and use of Anise are those of the **aromatic** oils in general. It is believed, however, to possess a specially stimulant action on the bronchial mucosa, like Ammoniacum, probably because excreted in part by it. It is therefore a favourite flavouring agent for cough mixtures.

Coriandri Fructus.—CORIANDER FRUIT. The dried ripe fruit of Coriandrum sativum. Cultivated in Britain.

Characters.—Nearly globular; consisting of 2 mericarps, crowned by the calyx teeth and stylopod, about $\frac{1}{5}$ inch in diameter, brownish-yellow, hard; faintly ribbed with both primary and secondary ridges; the mericarps enclosing a lenticular cavity, and each furnished on its commissural surface with 2 brown vittæ. Taste agreeable, mild, aromatic; odour, when bruised, pleasant.

Composition.—The principal constituents of Coriander are *aromatic oils,* one of which is official.

From Coriandri Fructus is made:

Oleum Coriandri.—Distilled in Britain from Coriander Fruit.

Characters.—Pale yellow or colourless, having the odour of the fruit and a mild aromatic taste. Has the composition of a hydrated oil of turpentine, $C_{10}H_{16},H_2O$, isomeric with Borneo camphor. (See *Camphora,* page 352.) *Dose,* 1 to 4 min.

Coriander Fruit is contained in Confectio Sennæ, Syrupus Rhei, Tinctura Rhei, Tinctura Sennæ; *the Oil in* Syrupus Sennæ.

ACTION AND USES.

The action and uses of Coriander do not differ from those of other **aromatic** substances. Its flavour specially covers the tastes of Senna and Rhubarb.

Fœniculi Fructus.—FENNEL FRUIT. The dried fruit of cultivated plants of Fœniculum capillaceum. Imported from Malta.

Characters.—Ovoid-oblong, $\frac{1}{5}$ to $\frac{2}{5}$ inch long, curved, capped by a conspicuous stylopod and two styles, smooth, greenish-brown; odour aromatic; taste aromatic, sweet, agreeable. Separable into 2 mericarps, each with 5 prominent ridges, the lateral the broadest; 4 vittæ in the grooves, and 2 on the commissure. *Substances resembling Fennel:* Conium, Caraway, Anise. Fennel is larger than Conium, and has prominent vittæ.

Composition. — Fennel contains a *volatile oil*, apparently identical with Oil of Anise. (*See* page 285.) It is light yellow, with the peculiar odour of the fruit.

Preparation.

Aqua Fœniculi.—10 from 1, by distillation. *Dose*, 1 to 2 fl.oz.

Fennel is also contained in Pulvis Glycyrrhizæ Compositus.

ACTION AND USES.

Fennel has the same action, and is used for the same purposes, as other **aromatic** substances.

Carui Fructus.—CARAWAY FRUIT. The dried fruit of Carum Carui. From England and Germany.

Characters.—Fruit usually separated into its 2 mericarps. These vary from $\frac{1}{6}$ to $\frac{1}{4}$ inch long; are slightly curved, tapering at each end, brown, with 5 paler longitudinal ridges, and in each interspace a large vitta. Odour aromatic; taste pleasant, sweetish, spicy. *Substances resembling Caraway:* Conium, Fennel. Caraway has small ridges and a spicy taste.

Composition.—The official *volatile oil of caraway* is the active constituent of the fruit.

Preparation.

Aqua Carui.—10 from 1, by distillation. *Dose*, 1 to 2 fl.oz.

From Carui Fructus is made:

Oleum Carui.—The oil distilled in Britain from Caraway Fruit. Pale yellow, with aromatic odour and spicy acrid taste. Is a mixture of *caruen*, $C_{10}H_{16}$, a terpene, and *caruol*, $C_{10}H_{14}O$, isomeric with thymol.
Dose, 1 to 4 min.

Caraway Fruit is contained in Confectio Opii, Pulvis Opii Compositus, Confectio Piperis, Tinctura Cardamomi Composita, and Tinctura Sennæ; *Oleum Carui in* Confectio Scammonii and Pilula Aloes Barbadensis.

ACTION AND USES.

Caraway acts like other **aromatic** substances. It is extensively used as a flavouring and carminative agent.

Anethi Fructus.—DILL FRUIT. The dried fruit of Peucedanum graveolens. Imported from Middle and Southern Europe.

Characters.—Broadly oval, about $\frac{1}{6}$ inch long, flat, with a broad membranous border. Colour brown; the border paler; the mericarps distinct. Odour and taste agreeably aromatic.

Substances resembling Dill: Conium, Anise, Fennel, Caraway. Dill is winged.

Composition.—Dill contains the official *volatile oil.*

Preparation.

Aqua Anethi.—10 from 1, by distillation. *Dose,* 1 to 2 fl.oz.

From Anethi Fructus is made:

Oleum Anethi.—The oil distilled in Britain from Dill Fruit. Pale yellow, with a pungent odour, and a hot sweetish taste. It contains a terpene *anethene* $C_{10}H_{16}$, and an oxydised oil, $C_{10}H_{14}O$, identical with caruol. *Dose,* 1 to 4 min.

ACTION AND USES.

The same as of other **aromatic** substances. It is given as a carminative to infants; and to cover the taste of Sodium salts.

Sumbul Radix. — SUMBUL ROOT. The dried transverse sections of the root of Ferula Sumbul. Imported from Russia and India.

Characters.—About 1 to 3 inches in diameter; $\frac{3}{4}$ to more than 1 inch thick. Covered externally with a dusky-brown papery transversely wrinkled bark, with short bristly fibres; internally spongy, coarsely fibrous, dry, farinaceous, dirty yellowish-brown, mottled with whitish patches and spots of exuded resin. Odour strong, musk-like; taste bitter, aromatic.

Composition.—Sumbul contains a small quantity of a *volatile oil;* 9 per cent. of a soft *resin,* with its characteristic odour; and a crystalline substance, *sumbulic acid.*

Preparation.

Tinctura Sumbul.— 1 in 8. *Dose,* 10 to 30 min.

ACTION AND USES.

Sumbul is a stimulant, like the **aromatic** oils in general, and specially resembles Valerian and Musk. It is used in the same class of cases as these drugs. (*See* page 304.)

CAPRIFOLIACEÆ.

Sambuci Flores.—ELDER FLOWERS. The fresh flowers of Sambucus nigra. From indigenous plants.

Characters.—In corymbose cymes, five to seven inches across. Flowers small; calyx superior, 5-toothed; corolla flat, rotate, 5-sected, creamy-white, with 5 stamens inserted in the tube. Odour fragrant, somewhat sickly; taste bitterish.

Composition.—Elder Flowers contain a trace of a *volatile oil*, a *resin*, and *valerianic acid*, $C_5H_{10}O_2$.

Preparation.

Aqua Sambuci.—1 in 1, by distillation. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Elder Flowers are chiefly used for **flavouring** purposes, but probably possess mild diaphoretic and diuretic properties.

CINCHONACEÆ.

Cinchonæ Rubræ Cortex. — RED CINCHONA BARK. The dried bark of the stem and branches of cultivated plants of Cinchona succirubra.

Characters.—Quills or incurved pieces, coated with periderm; from a few inches to a foot or more in length, the bark itself $\frac{1}{10}$ to $\frac{1}{4}$ inch thick, rarely more; outer surface rough from longitudinal furrows and ridges, or transverse cracks, annular fissures, and warts, and reddish-brown; inner surface brick-red, irregularly and coarsely striated. Powder reddish-brown. No marked odour; taste bitter, somewhat astringent.

Cinchonæ Cortex. — CINCHONA BARK. The dried bark of Cinchona Calisaya, Yellow Cinchona; Cinchona officinalis, Pale Cinchona; Cinchona succirubra, Red Cinchona; Cinchona lancifolia, Columbian Bark; and other species of Cinchona from which the peculiar alkaloids of the bark may be obtained. From Ceylon, India, Jamaica, and South America.

(Salts of Quinine and Cinchonine may also be obtained from some species of Remijia.)

Composition.—(*A*) Cinchona Bark contains (1) four *alkaloids*, namely: *quinine, cinchonine, quinidine,* and *cinchonidine;* (2) two *peculiar acids, kinic* and *kinoric* acids; (3) a variety of tannic acid, called *cincho-tannic acid;* (4) *cinchona red;* and (5) an aromatic *volatile oil.*

1. **The alkaloids of cinchona.**—*a. Quinine,* $C_{20}H_{24}N_2O_2$, occurs (as the hydrate) in white acicular crystals, inodorous, very bitter. It reacts like an alkali, forming neutral and acid salts with acids; fluorescent in dilute solutions of the Sulphate; turning the plane of polarisation to the left; and yielding in solution a green colour when treated with Cl water and then with NH_4HO. An *amorphous* form of Quinine is obtained after crystallisation of the Sulphate from the mother liquor, or from *quinoidine,* which appears to be a compound of the alkaloid with resin and colouring matters.

b. Cinchonine, $C_{20}H_{24}N_2O$, consists of colourless prisms, inodorous, and bitter; forms salts with acids; but possesses no fluorescence in solution; is dextrogyrate, and gives no green colour with Cl water and NH_4HO.

c. Quinidine, $C_{20}H_{24}N_2O_2$, *i.e.* isomeric with Quinine, closely resembles it, but crystallises in prisms, and is dextrogyrate.

d. Cinchonidine, $C_{20}H_{24}N_2O$, *i.e.* isomeric with Cinchonine, resembles that alkaloid, but yields indistinctly fluorescent solutions, and left-handed polarisation.

As a rule Quinine is most abundant in yellow bark, Cinchonine in pale bark, and the red bark contains a considerable proportion of each. Quinidine is specially abundant in the bark of lancifolia. More exactly, Yellow Bark should yield 2·5 to 3·8 per cent. of Quinine; Pale Bark, 0·7 to 1·4 per cent. of alkaloids, chiefly Cinchonine or Quinidine with a little Quinine; the best Red Bark 5 to 6 per cent. of alkaloids, not less than a half being Quinine and Cinchonidine.

2 and 3. **The acids of cinchona.**—*a. Kinic* or *quinic* acid, $C_7H_{12}O_6$, occurs in large colourless prisms, soluble in water. In the bark it is probably combined with the alkaloids, and is found also in the Coffee-bean, the Vaccinium myrtillus, and other plants. It is closely allied to benzoic acid, and appears in the urine as hippuric acid.

b. Kinoric acid, $C_{24}H_{38}O_4$, "kinova bitter," is a white amorphous body, insoluble in water. It appears to be a product, with glucose, of *kinovin,* a glucoside, $C_{30}H_{48}O_8$.

c. Cincho-tannic acid, the astringent principle and soluble red-colouring matter of the bark, amounts to 1 to 3 per cent. It is a yellow hygroscopic body, and differs from ordinary tannic acid in striking green with persalts of iron, and in being very readily oxydised, one of the products being:

4. **Cinchona red,** a reddish-brown substance, without taste or smell, nearly insoluble in water.

5. **The volatile oil,** obtained by distillation, has the odour of the bark.

(*B*) Remijia Bark yields more or less of the cinchona alkaloids, and also a principle, *homoquinine*, which has been resolved into quinine and a new alkaloid, *cupreine.*

Impurities.—Inferior barks are detected by the absence of the true characters of the official barks, and by a quantitative test for (I.) Quinine and Cinchonine, and (II.) the total alkaloids, as follows: I. *For Quinine and Cinchonine:* This consists in (1) intimately mixing 200 gr. of bark with 60 gr. of hydrate of calcium, and moistening with water; (2) boiling and percolating with benzolated amylic alcohol, to exhaust the bark; (3) shaking the filtrate with HCl and water, to separate the alkaloids as hydrochlorates; (4) neutralising with ammonia and concentrating; and (5) adding a solution of 15 gr. of tartarated soda, to separate the insoluble tartrates of quinine and cinchonine, $\frac{8}{10}$ of which will consist of quinine and cinchonine. One-half of this weight gives the percentage of these alkaloids.

II. *For total alkaloids.*—This consists in precipitating the other alkaloids by adding ammonia in excess to the mother liquor of I. One-half the weight of these, added to the percentage weight of quinine and cinchonine, gives the percentage of total alkaloids.

Incompatibles.—Ammonia, lime-water, metallic salts and gelatine. May be combined with mineral acids. *Dose* of Bark, 15 gr. as a tonic; 1 to 2 dr. in ague.

Preparations.

A. *Of Cinchonæ Rubræ Cortex:*

1. **Decoctum Cinchonæ.**—1 in 16. *Dose,* 1 to 2 fl.oz.
2. **Extractum Cinchonæ Liquidum.**—Made by extracting with Hydrochloric Acid, Glycerine, and Water; evaporating to a definite strength; and adding Spirit and Water. 100 fl.gr. contain 5 gr. of the alkaloids of the bark. *Dose,* 5 to 10 min.
3. **Infusum Cinchonæ Acidum.**—1 in 20, with ¼ Aromatic Sulphuric Acid. *Dose,* 1 to 2 fl.oz.
4. **Mistura Ferri Aromatica.**—1 in 16. See *Ferrum,* page 83.
5. **Tinctura Cinchonæ.**—1 in 5 of *Proof* Spirit. *Dose,* ½ to 2 fl.dr.
6. **Tinctura Cinchonæ Composita.**—Red Cinchona Bark, 2 oz.; Bitter Orange Peel, 1 oz.; Serpentary, ½ oz.; Saffron, 55 gr.; Cochineal, 28 gr.; *Proof* Spirit, 1 pint. *Dose,* ½ to 2 fl.dr.

B. *From Cinchonæ Cortex are made:*

1. **Quininæ Sulphas.**—Sulphate of Quinine. $((C_{20}H_{24}N_2O_2)_2H_2SO_4)_2 15H_2O$.

Source.—Made from the powder of various kinds of Cinchona and Remijia Bark by extraction with Spirit after the addition of Lime, or by the action of alkali on an acidulated aqueous infusion, with subsequent neutralisation of the alkaloid by Sulphuric Acid, and purification of the resulting salt.

Characters and tests.—Filiform, silky, snow-white crystals, of a pure intensely bitter taste. *Solubility.*—1 in 700 or 800 of cold water, imparting to it a fluorescent tint; entirely soluble in water acidulated by H_2SO_4. Solution of Ammonia gives with solutions a white precipitate of quinine, soluble in excess and in ether. Dissolved in H_2SO_4, gives a yellowish tint, which remains unchanged by gentle warming.

Impurities.—It should not contain much more than 5 per cent. of sulphates of other cinchona alkaloids. Lime, chalk, magnesia, starch, boric acid, etc.; detected by quantitative test. Salicin; which gives blood-red with H_2SO_4. *Incompatibles.*—Alkalies and their carbonates, astringent infusions. In mixtures, 1 min. of a diluted mineral acid will dissolve each grain. *Dose*, 1 to 5 gr., as a tonic; 5 to 20 gr., as an antipyretic and antiperiodic. (*See* page 296.)

Preparations.

1. **Ferri et Quininæ Citras.**—16 in 100. *See* page 80. *Dose*, 5 to 10 gr.
2. **Tinctura Quininæ Ammoniata.**—160 gr.; Solution of Ammonia, 2½ fl.oz.; *Proof* Spirit, 17½ fl.oz. *Dose*, ½ to 2 fl.dr.
3. **Vinum Quininæ.**—20 gr.; Citric Acid, 30 gr.; Orange Wine, 1 pint. *Dose*, ½ to 1 fl.oz.

2. **Quininæ Hydrochloras.**—Hydrochlorate of Quinine. $C_{20}H_{24}N_2O_2HCl,2H_2O$.

Source.—Made like Sulphate of Quinine, the separated alkaloid being neutralised by Hydrochloric Acid.

Characters.—Crystals resembling those of Sulphate of Quinine, or larger. *Solubility.*—1 in 34 of cold water, 1 in 3 of spirit; very soluble in the boiling liquids. *Dose*, 1 to 10 gr.

Preparation.

Tinctura Quininæ.—1 gr. in 1 fl.dr. of Tincture of Orange Peel. *Dose*, ½ to 2 fl.dr.

3. **Cinchonidinæ Sulphas.**—Sulphate of Cinchonidine. $(C_{20}H_{24}N_2O)_2,H_2SO_4,3H_2O$.

Source.—Made from the mother-liquors of the crystallisation of Sulphate of Quinine by further concentration; purified by crystallisation from alcohol, and finally from hot water.

Characters and tests.—In colourless silky crystals, usually acicular. Soluble in water, alcohol, or ether; almost insoluble in chloroform, or in solution of ammonia; readily soluble in diluted acids. Aqueous solution bitter; neutral, or faintly alkaline; lævogyrate; when acidified is not distinctly fluorescent; gives a white precipitate with tartarated soda, in the filtrate from which mixture solution of ammonia causes but a slight turbidity. *Dose*, 1 to 10 gr.

4. **Cinchoninæ Sulphas.**—Sulphate of Cinchonine. $(C_{20}H_{24}N_2O)_2,H_2SO_4,2H_2O$.

Source.—Made from the mother-liquors of the crystallisation of the sulphates of Quinine, Cinchonidine, and Quinidine, by precipitating the alkaloid with Caustic Soda; washing it with Spirit until free from other alkaloids; dissolving in Sulphuric Acid; purifying with charcoal, and crystallising.

Characters and tests.—Hard, colourless, short prisms, with a vitreous lustre. Soluble in water, and in chloroform; almost insoluble in ether, and in Solution of Ammonia; readily in spirit and in diluted acids. Aqueous solution bitter, neutral, or faintly alkaline; dextrogyrate. Acidified solution not fluorescent. *Dose*, 1 to 10 gr.

ACTION AND USES.

The action and uses of the Cinchona Barks will be described along with those of Quinine, their most important active principle.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Quinine arrests some kinds of fermentation and decomposition, and might therefore be used as a local **antiseptic and disinfectant** to wounds and ulcers, but for its cost. A solution of 2 gr. to 1 fl.oz., applied as a spray to the nose, relieves hay asthma. A solution of 4 gr. to 1 fl.oz., with a minimum of Diluted Sulphuric Acid, is recommended as a constant application in diphtheritic conjunctivitis, or to wash out a foul bladder.

Internally.—Quinine is freely absorbed by the mucous membranes, and may be given either by the mouth, by the rectum as suppository, or subcutaneously. In the mouth, stomach, and intestine, it acts as a powerful **bitter**, possessing all the important influence on the secretions of the digestive tract described under *Calumba.* The **stomachic** effect of Quinine is obtained from small doses, ½ to 2 grains, and must be kept entirely distinct from the specific effects to be presently described, otherwise confusion as to the action and value of this important drug will be the result. In small doses, like all other bitters, it improves the appetite and digestion, stimulates the heart and circulation, increases the sense of comfort and *bien être* produced by a meal; and its continued use will thus increase the bodily strength, that is, will be **tonic** in its effects. Quinine is extensively used for this purpose, especially during convalescence, in debilitated subjects, and in patients taking depressing or alterative remedies such as mercury. Larger doses (10 to 30 gr. or more), have the opposite effect, interfering with digestion, and so causing depression.

In the stomach Quinine or its salts become the chloride, a soluble and diffusible salt which readily enters the blood. Little or none escapes unabsorbed in the fæces.

2. ACTION IN THE BLOOD, AND ITS USES.

Quinine or its chloride may be found in the blood within a few minutes of its administration. Here the alkaloid produces several definite effects, namely: (1) It binds the oxygen more firmly to the hæmoglobin, so that oxygenation is less easy and less active. (2) It causes enlargement of the individual red corpuscles. (3) It paralyses the leucocytes, when given in large doses, thus checking diapedesis; and reduces the number of visible leucocytes very greatly (to one-fourth). In blood freshly drawn, it (4) retards the formation of acid (loss of oxygen and increase of carbonic acid) which naturally occurs in blood removed from the vessels; and (5) it reduces the ozonising power of blood, *e.g.* on guaiacum and turpentine. Altogether, Quinine manifestly **interferes with oxygenation,** the giving up of oxygen by the red corpuscles to oxydisable bodies, and with the functions of the white corpuscles. The outcome of these effects will be presently considered.

3. SPECIFIC ACTION.

Quinine passes through the tissues without decomposition, quickly making its appearance in them, but not being completely excreted for several days, especially in fever. The maximum effect of large doses is produced in about five hours.

If, therefore, the full specific effect be desired, a single large dose (15 to 30 gr.) must be given, and this may have to be repeated once or twice within the hour; small doses given over a length of time do not sufficiently accumulate.

The obvious phenomena produced by a full dose (15 to 30 gr.) of Quinine are not by any means its most important effect. It acts most strikingly upon the nervous centres, and causes confusion of the mental faculties, noises in the ears and deafness, disorders of vision, headache, giddiness, vomiting, and possibly prostration from involvement of the cord and circulation. Of infinitely greater interest and importance are certain concomitant effects of Quinine which require careful investigation for their discovery. These effects may be arranged thus:

(1) Quinine **lowers the body temperature** very moderately in the healthy subject; very markedly in the pyrexia of many acute specific fevers. It appears to be difficult to lower the normal temperature by drugs, as compensating mechanisms are probably brought into play; but the rise of temperature and the perspiration normally produced by muscular exercise are prevented by Quinine. In malarial fevers, typhoid, acute pneumonia, and some forms of hectic and other periodic fevers, the defervescent effect of Quinine is unquestionable.

(2) Quinine **reduces the amount of nitrogenous excretions,** *i.e.* urea and uric acid, and probably also of carbonic acid, as determined both in healthy and fevered animals, and in man.

These two sets of effects taken together point to a powerful action of Quinine in reducing the metabolism of the body, of which heat and the excretions are the two most measurable products. This conclusion is supported by other facts, observed out of the body, viz. that: (3) a solution of albumen cannot be converted into peptone in an atmosphere of ozone if Quinine be present. (4) Healthy pus and fresh vegetable juices lose their ozonising power if mixed with Quinine. (5) Phosphorescent infusoria (rapidly oxydating protoplasmic masses) lose their phosphorescence in the presence of Quinine. (6) Fungi absorb oxygen less readily, and many forms of fermentation are arrested, in the presence of Quinine. These facts indicate that Quinine so combines with living cellular protoplasm as to render it less able to incorporate oxygen, and more resistant of vital change (metabolism). We have already seen that the oxygen actually in the corpuscles is bound more firmly to them by Quinine. We may therefore conclude that the effect of Quinine in the body is to check metabolism by interfering with the oxydation of protoplasm generally, with oxygenation, and with the associated action of ferments. Thus the fall of temperature produced by Quinine is due to diminished production of heat in the body, not to increased loss of heat; it is effected through the tissues, not through the heat regulating centre; and the fever-causing processes themselves (probably allied to fermentations) are also controlled by the drug, which affects their organic causes, whether living organisms or complex chemical substances.

An action such as this upon the processes of nutrition, though it might escape the notice of an ignorant observer, is more "powerful" even than the action of Morphine upon a highly-sensitive nervous mechanism such as the convolutions.

Turning to the other systems, we find that whilst small doses of Quinine accelerate the heart and raise the pressure, as we saw when considering its action on the stomach, full doses diminish the force and frequency of systole, strengthen diastole, and lower the pressure; effects due to a direct action on the cardiac ganglia and muscle, and on the vessel walls and their centre. Respiration is accelerated by medium doses, depressed by large doses; and death, should it occur, is referable to respiratory and cardiac failure. The spleen is reduced in size, and hardened.

4. SPECIFIC USES.

The uses of Quinine, which have been mainly established by experience, are in accord with these physiological results. Its specific action may be employed in the following diseases:

1. *Malaria* is remarkably benefited by Quinine, which is an **antiperiodic** or direct specific, whether given to persons exposed to the morbid influence as a prophylactic measure, or to the subjects of ague. It acts best in fresh cases, the first dose of 10 gr. being given at any time in relation to the attack, and a similar dose five hours before the time of the next paroxysm. All forms of malarial fever are benefited by Quinine, as well as many diseases and disorders of malarial origin, such as neuralgia, hepatic disturbances, etc. The functions of the liver must be maintained during this treatment; and the Quinine may be combined with Morphine if its effects are not well marked.

2. *Febrile conditions in general* are relieved by the **antipyretic** effect of Quinine, for instance, acute pneumonia, typhoid fever, puerperal fever and septicæmia, the exanthemata, and acute rheumatism; but generally in very different degrees, so that its value is questioned in some or all of them. To be of use, the Quinine must be very freely given (10 to 20 grains) as single doses when the temperature reaches a definite height, say 104° Fahr. Even if apyrexia do not follow, the drug may be of much benefit. In hectic fever Quinine is rarely of much service; and in purely symptomatic fever, of still less.

3. In *splenic enlargement* of malarial origin Quinine is given with success, and in some cases of leukæmatous hypertrophy.

4. In *painful nervous affections*, especially headache and face-ache, the effect of Quinine is well marked. Some of these cases are malarial (brow ague); but ordinary facial neuralgia and toothache will frequently yield to it. Yet Quinine possesses no direct action on peripheral nerves.

5. In certain *cardiac diseases* a combination of Quinine and Digitalis may be of great service, diastole being prolonged and strengthened whilst systole is left unaffected.

6. The **tonic** effect of Quinine has been already referred to. This is also due in part to the removal of fever, and thus of restlessness, sleeplessness, and want of appetite. Modifying as it does the metabolic processes in the liver, Quinine may relieve hepatic disorder due to free living, especially in persons who have resided in the tropics.

5. REMOTE LOCAL ACTION AND USES.

Quinine is excreted chiefly in the urine, as the amorphous alkaloid; partly as resinoid and crystalline derivatives. In passing through the urinary organs it is slightly diuretic, and may irritate the passages. It also escapes by the skin, diminishing perspiration, and very rarely causing an itching eruption which resembles scarlatina or measles. All the secretions, the milk, and pathological fluids may contain Quinine.

Action and Uses of the Cinchona Barks.

The Cinchona Barks contain but a small percentage of alkaloids, and are far too bulky for use as antiperiodics and antipyretics if Quinine can be obtained. They are therefore given only as **bitter stomachics and tonics.** The amount of tannin contained in them indicates that they may be used when an astringent effect is also desired, either locally, as in passive diarrhœa, or remotely, as in sweating, chronic mucous discharges, and purulent formations; and avoided in constipation, dyspepsia, or irritability of the bowels. The Red Bark is especially astringent.

Action and Uses of the other Cinchona Alkaloids.

Cinchonine and other alkaloids and products of Bark may be employed as substitutes for Quinine, their action being very similar. Cinchonine is from $\frac{1}{3}$ to $\frac{1}{2}$ as powerful as Quinine. Cinchonidine is said to cause epileptiform convulsions in animals.

Ipecacuanha.—IPECACUANHA. The dried root of Cephaëlis Ipecacuanha. Imported from Brazil.

Characters.—More or less twisted pieces, usually 2 to 4 inches long, about the size of a small writing quill. It consists of two parts: a central inert whitish woody axis; and a thick cortical active portion, which is brownish, annulated, with a resinous or waxy fracture. Taste acrid and bitter; odour slight, peculiar, especially when powdered. *Impurities.*—(1) Hemidesmus, which is cracked, but not annulated; (2) almond meal (in powdered ipecacuanha), detected by odour of prussic acid when moistened.

Composition.—Ipecacuanha contains from ¼ to 1 per cent. of *emetine*, which is its active principle; *ipecacuanhic* or *cephaëlic acid*, a glucoside; starch, gum, etc. *Emetine*, $C_{20}H_{30}NO_5$, is a crystalline alkaloid, white becoming yellow, odourless, bitter, comparatively insoluble in water, forming unstable salts with acids which are readily dissolved in ordinary media.

Dose.—As expectorant, ½ to 2 gr.; as emetic, 15 to 30 gr.

Preparations.

1. **Pulvis Ipecacuanhæ Compositus.** "Dover's Powder."—Ipecacuanha, 1; Opium, 1; Sulphate of Potassium, 8. A light fawn-coloured powder. 1 in 10. *Dose*, 5 to 10 gr.

From Dover's Powder is prepared:

PILULA IPECACUANHÆ CUM SCILLÂ.—Compound Powder of Ipecacuanha, 3; Squill, 1; Ammoniacum, 1; Treacle, q.s. 1 in 23 nearly. *Dose*, 5 to 10 gr.

2. **Trochisci Ipecacuanhæ.**—¼ gr. in each. *Dose*, 1 to 3.
3. **Trochisci Morphinæ et Ipecacuanhæ.**—Ipecacuanha, $\frac{1}{12}$ gr.; Hydrochlorate of Morphine, $\frac{1}{36}$ gr. in each. See *Opium*.
4. **Vinum Ipecacuanhæ.**—An acetic extract, dried, powdered, dissolved in Sherry, and filtered. 1 in 20. *Dose*, 5 to 40 min. as an expectorant: as an emetic, 3 to 6 fl.dr.

Ipecacuanha is contained in Pilula Conii Composita. *See* page 281.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Ipecacuanha powder is irritant to the skin, or even pustulant, but is never used to produce these effects. Exposed mucous membranes are similarly affected by it. If taken as snuff it causes irritation of the nerves, sneezing, and reflex mucous secretion; and the same effects follow its application as smoke or spray to the pharynx, larynx, or lower air passages. In some persons it excites asthma. In the form of a spray of the diluted Vinum, or inhaled as the smoke of the burning powder, it is used to relieve cough due to dryness or deficient secretion of the throat and air passages.

Internally.—Reaching the stomach, Ipecacuanha in very small doses (gr. ¼) is a **gastric stimulant**, doubtless increasing the local circulation and secretion. It is therefore a useful addition to bitter stomachic and tonic mixtures, and will even arrest vomiting due to certain obscure conditions of the gastric nerves. The Compound Powder is of great value in ulceration of the stomach, and in some forms of dyspeptic vomiting. In doses of 15 to 30 gr., Ipecacuanha acts as an **emetic**, partly by a direct effect upon the stomach, partly by exciting the vomiting centre in the medulla (indirect emesis). This subject will be discussed under the heading of the specific action of the drug.

In the intestines, Ipecacuanha is still a stimulant, increasing the flow of mucus; in large doses an irritant. A remarkable tolerance of the drug is, however, readily established in many persons suffering from **dysentery**, in which disease Ipecacuanha has the power of arresting the inflammatory action in the bowel, checking the liquid and bloody evacuations, and often effecting a complete cure. For this purpose enormous doses (30 to 90 gr.) are given, or large doses frequently repeated (20 gr. every two hours).

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Passing through the blood, from the alimentary canal to the tissues, Emetine acts on the vomiting centre in the medulla, *i.e.* is an **indirect emetic**, this effect being added to the direct (gastric) action already mentioned. Ordinary doses (15 to 30 gr. of the powdered root, 3 to 6 fl.dr. of the Vinum for adults) produce free evacuation of the stomach and respiratory passages in 20 to 30 minutes, the dose often having to be repeated in 15 minutes, and vomiting occurring probably but once. But little nausea precedes, and moderate depression follows, the emesis. The circulation and respiration are disturbed and finally depressed, chiefly through the vomiting.

Ipecacuanha is suitable as an emetic in cases where the necessity for evacuation of the stomach is not very urgent, and the subject likely to be benefited by moderate, but injured by great depression. It must not be given, therefore, in poisoning by alkaloids, such as Morphine, but to children and weakly subjects in cases where the after effects of the drug will also be useful. It thus occupies a position amongst emetics between Sulphate of Zinc or Copper and Tartar Emetic. Ipecacuanha may be used to empty the stomach in the early stages of sthenic fevers (less commonly than before); in croup, whooping-cough, and the bronchitis of children, to expel membranes or mucous products from the air passages; and in acute dyspepsia with biliousness and heat of skin.

The skin is stimulated to increased secretion by Ipecacuanha, which is used as a **diaphoretic**, combined with Opium (Dover's Powder), in colds, sore throat, and mild rheumatic attacks.

4. REMOTE LOCAL ACTION AND USES.

Emetine is excreted by the various mucous membranes, including those of the bronchi, the stomach, and bowels, and by the liver. On the bronchi it produces the same remote as immediate local action, namely, stimulation of the nerves, reflex cough, increased secretion, and, in large doses, even inflammation of the mucous membrane and lungs. Ipecacuanha is thus an expectorant, increasing at once the expulsive acts, and the amount, that is the liquidity, of the sputa. It is the most generally used of all this class of measures, being given in acute and chronic bronchitis, in phthisis, and in most cases of cough when the phlegm is scanty and tough. Its special advantages are, that, if taken in excess, it causes sickness, which is often beneficial in the bronchitis of children; and that as a diaphoretic and moderate depressant of the circulation, *i.e.* a **sedative expectorant**, it controls the accompanying fever.

Acting remotely on the liver, this drug is a **direct cholagogue**, increasing the secretion of bile; and has long been a favourite constituent of some purgative pills and aperient draughts for chronic biliousness and gouty dyspepsia.

Catechu.—CATECHU. An extract of the leaves and young shoots of Uncaria Gambier. Prepared at Singapore and in the Eastern Archipelago.

Characters.—Cubes, separate or agglutinated, about 1 inch square; deep reddish-brown externally, pale cinnamon-brown internally; dry, with earthy fracture; microscopically presenting myriads of acicular crystals. No odour; taste bitter, astringent, then sweetish. Soluble in boiling water.

Composition.—Catechu chiefly contains a crystalline bitter substance, *catechin* or *catechuic acid*, $C_{13}H_{12}O_5$, probably itself inactive; and *catechu-tannic* acid, the active principle, isomeric with it, and into which it is rapidly converted by boiling or by the action of saliva, with the development of a red colour. Both acids give a green precipitate with persalts of iron.

Incompatibles: The alkalies, metallic salts, and gelatine. *Impurity,* starch. *Dose,* 10 to 30 gr.

Preparations.

1. **Infusum Catechu.**—Catechu, 5⅓: Cinnamon, 1; Boiling Water, 149. *Dose,* 1 to 2 fl.oz.
2. **Pulvis Catechu Compositus.**—Catechu, 4; Kino, 2; Rhatany, 2; Cinnamon, 1; Nutmeg, 1. *Dose,* 20 to 40 gr.
3. **Tinctura Catechu.**—Catechu, 2½; Cinnamon, 1; *Proof* Spirit, 20. *Dose,* ½ to 2 fl.dr.
4. **Trochisci Catechu.**—1 gr. in each. *Dose,* 1 to 6.

ACTION AND USES.

Catechu acts like Tannic Acid, and is used for the same purposes. It is a favourite **astringent** application to sore throat in the form of the Lozenge, and the Compound Powder and Tincture are very commonly prescribed for diarrhœa.

Caffeina. — CAFFEINE. THEINE. GUARANINE. $C_8H_{10}N_4O_2,H_2O$. An alkaloid usually obtained from the dried leaves of Camellia Thea, the tea plant, or the dried seeds of Coffea arabica, the coffee plant, by evaporating aqueous infusions from which astringent and colouring matters have been removed.

Characters and tests.—Colourless, silky, inodorous needles. *Solubility:* 1 in 80 of cold water, the solution faintly bitter, and neutral; more readily in boiling water, and in spirit; very readily in chloroform; sparingly in ether. Treated with a crystal of $KClO_3$ and HCl, and the mixture evaporated to dryness in a porcelain dish, a reddish residue results, which becomes purple when moistened with NH_4HO. In aqueous solution, tannic acid gives a white precipitate, soluble in excess. Tea contains 1 to 4 per cent. of Caffeine, with tannin, volatile oil, etc.; Coffee, 0·2 to 0·8, with volatile oil, sugar, tannin, etc.; Maté, 1·2; Guarana, 5 per cent. It is closely allied to theobromine, $C_7H_8N_4O_2$, being, in fact, methyl-theobromine, $C_7H_7(CH_3)N_4O_2$, which can be made synthetically. *Incompatibles:* Tannic acid, iodide of potassium, and salts of mercury. *Dose,* 1 to 5 gr. or more.

From Caffeina is made:

Caffeinæ Citras.—CITRATE OF CAFFEINE. $C_8H_{10}N_4O_2,H_3C_6H_5O_7$. A weak compound of Caffeine and Citric Acid.

Source.—Made by dissolving Citric Acid and Caffeine in hot water; evaporating to dryness; and pulverising.

Characters and tests.—A white inodorous powder, with an acid faintly bitter taste; reaction acid. Soluble in a mixture of 2 of chloroform and 1 of spirit. With a little water it forms a clear syrupy solution, which on dilution yields a white precipitate of Caffeine, redissolving in 10 parts of water. Reactions otherwise as of Caffeine. *Dose*, 2 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Coffee stimulates most of the digestive glands, being sialagogue, **stomachic and slightly laxative.** So far it is dietetically wholesome.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Caffeine is absorbed into the circulation unchanged; and acts chiefly upon the central nervous system. The **cerebrum is first stimulated**; whence the clearness of intellect, the removal of languor, and the sleeplessness, familiar after a cup of strong tea or coffee. Larger doses cause a species of narcotism; but there are great differences in this and in other respects according to the individual and other circumstances. In the lower animals the spinal centres are simultaneously affected to such a degree that tetanic convulsions may occur, not unlike those caused by Strychnine; in man these effects on the lower centres are quite subsidiary. The sensory and motor peripheral nerves are not certainly affected. The muscle curve is altered in character, and **muscular contraction seems more easily executed.** Caffeine first **strengthens and lengthens the cardiac systole,** whilst diastole is shortened; and finally arrests the heart in systole. The blood pressure first rises and then falls. Respiration is temporarily increased, then depressed. Metabolism is but little influenced; the temperature is raised. In all respects habit markedly weakens the influence of Coffee.

Coffee or Caffeine may be used as a nervine stimulant and restorative in ordinary conditions of fatigue. Megrim is frequently relieved by either. It is given with benefit in cardiac disease, especially failure of compensation with dropsy; being more rapid and less irritant than Digitalis. The Citrate, being a weak salt, should be combined with Salicylate or Benzoate of Sodium, forming a more stable compound. Large doses must be avoided.

3. REMOTE LOCAL ACTION AND USES.

But a small proportion of Caffeine is excreted unchanged in the bile and urine. In passing through the kidney, it or its products appear to stimulate the cells; and in this way, as well as by its influence on the heart and vessels, it acts as a diuretic. The Citrate is a powerful but somewhat uncertain remedy in dropsy, whether cardiac or hepatic. It is best given after or with a stimulant diuretic, such as Digitalis; for a short time only; and in moderate doses.

VALERIANACEÆ.

Valerianæ Rhizoma.—VALERIAN RHIZOME. The dried rhizome and rootlets of Valeriana officinalis. Collected in autumn from plants growing wild or cultivated in Britain.

Characters.—Short, erect, entire or sliced; yellowish-brown externally; with numerous slender brittle shrivelled rootlets 3 or 4 inches long, of the same colour; whitish internally. Odour, on drying, strong, peculiar, disagreeable; taste unpleasant, camphoraceous, bitter. *Substances resembling Valerian:* Serpentary, Arnica, Veratrum Viride, known by odour.

Composition.—The active principles are (1) a *volatile oil*, and (2) *valerianic acid*. (1) The *oil* consists of a terpene, *valerene or borneène*, $C_{10}H_{16}$, and *valerian camphor*, $C_{12}H_{20}O$, *valerol*. (2) *Valerianic acid*, $HC_5H_9O_2$, occurs in many other plants, and in cod-liver oil; and can be derived from amylic alcohol (valeryl-aldehyde), $C_5H_{11}HO$, by oxydation. (*See* page 160.) It is a colourless oily fluid, with a powerful odour and acrid burning taste; soluble in 30 parts of water, freely in alcohol and ether. *Dose, in powder*, 10 to 30 gr.

Preparations.

A. *Of Valerianæ Rhizoma:*

1. **Infusum Valerianæ.**—1 in 40. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Valerianæ.**—1 in 8 of *Proof* Spirit. *Dose*, 1 to 2 fl.dr.
3. **Tinctura Valerianæ Ammoniata.**—1 in 8 of Aromatic Spirit of Ammonia. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

B. *Containing Valerianic Acid:*

Sodii Valerianas.—Valerianate of Sodium. $NaC_5H_9O_2$.
Source.—Made by (1) distilling Amylic Alcohol with solutions of Sulphuric Acid and Bichromate of Potassium; (2) saturating the distillate with Liquor Sodæ; evaporating, fusing, cooling, and breaking into pieces. (1) $3C_5H_{11}HO$

$+8H_2SO_4 + 2K_2Cr_2O_7 = 3HC_5H_9O_2 + 2(K_2SO_4,Cr_23SO_4) + 11H_2O$. (2) $HC_5H_9O_2 + NaHO = NaC_5H_9O_2 + H_2O$.

Characters.—Dry white masses; not alkaline; soluble in water and in spirit. Gives out odour of Valerian on addition of Diluted Sulphuric Acid. *Impurities.*—Sulphuric acid or free soda. *Dose*, 1 to 5 gr.

From Sodii Valerianas is made:

Zinci Valerianas.—Valerianate of Zinc. $Zn(C_5H_9O_2)_2$.

Source.—Made by mixing hot solutions of Sulphate of Zinc and Valerianate of Sodium, evaporating, crystallising, and washing. $ZnSO_4 + 2(NaC_5H_9O_2) = Zn(C_5H_9O_2)_2 + Na_2SO_4$.

Characters.—Pearly crystalline scales, with a feeble odour of valerianic acid, and a metallic taste. *Solubility.*—1 in 120 of water, 1 in 60 of spirit. *Incompatibles.*—All acids, soluble carbonates, most metallic salts, vegetable astringents. *Impurities.*—Sulphate and butyrate of zinc. *Dose*, 1 to 3 gr.

ACTION AND USES.

Valerian acts essentially like other substances containing volatile oils, but its pungent taste and peculiarly disagreeable odour increase the effect on the central nervous system. The stomach and intestines, heart, circulation, and brain are influenced as they are by Cloves (*see* page 273), and the oil is excreted in the urine, breath, and sweat, as is also the acid.

Valerian is used as a powerful **carminative, circulatory stimulant, and antispasmodic**, in hysterical flatulence, fainting, palpitation, convulsions, and *contractures*. It is now but rarely given in other spasmodic affections, such as epilepsy.

Valerianate of Zinc was introduced to combine the alterative action of the metal on the nervous system with the antispasmodic influence of the plant, and has been given in hysteria and epilepsy; but Valerianic Acid does not appear to possess the action of the volatile oil just described.

COMPOSITÆ.

Pyrethri Radix.—Pellitory Root. The dried root of Anacyclus Pyrethrum. From the Levant.

Characters.—Unbranched pieces, 2 to 4 inches long, $\frac{1}{2}$ to $\frac{3}{4}$ inch thick, cylindrical, with a thickish brown shrivelled bark, studded by dark-coloured receptacles of resin. Fracture close;

fractured surface radiate. Inodorous; when chewed it causes a burning pricking sensation over the mouth and throat. *Substance resembling Pellitory:* Taraxacum, which is darker and of different taste.

Composition.—Pyrethrum contains one or more *volatile oils*, and *resins; inulin*, $C_6H_{10}O_5$, a white powder occupying the place of starch in the roots of this and some other plants; and possibly a substance allied to *piperine;* see *Piper Nigrum.*

Preparation.

Tinctura Pyrethri.—1 in 5.

ACTION AND USES.

Pellitory causes a sharp burning sensation in the mouth, followed by persistent tingling and numbness, and a profuse flow of saliva, stimulating as it does the local nerves and vessels, and afterwards depressing the former. It is used chiefly as a **sialagogue** in dryness of the throat; and to give a "clean" taste to flat dentifrices, such as chalk.

Pyrethrum Roseum. (*Not official.*)—The powder of the flower-heads. Used as insect powder.

Santonica.—SANTONICA. The dried unexpanded flower-heads or capitula of Artemisia maritima, *var.* Stechmanniana (Artemisia pauciflora). From Russia.

Characters.—About $\frac{1}{10}$ inch long, oblong-ovoid, obtuse, pale greenish-brown, nearly smooth; resembling seeds, but consisting of 12 to 18 imbricated involucral scales, with a broad thick yellowish-green midrib, enclosing 3 to 5 tubular florets. Odour, when rubbed, strong, peculiar, camphoraceous; taste bitter, camphoraceous.

Composition.—Santonica contains *santonin*, and a compound *volatile oil*, allied to camphor in its action. *Dose*, 10 to 60 gr.

From Santonica is made:

Santoninum.—Santonin. $C_{15}H_{18}O_3$. A neutral crystalline principle obtained from Santonica.

Source.—Made by (1) boiling Santonica with Lime in Water, and straining; (2) acidulating the hot concentrated fluid portion with Hydrochloric Acid, to precipitate tho Santonin; (3) washing this with Ammonia and Water, and drying; and (4) digesting it with boiling Spirit and Charcoal, filtering, and crystallising.

Characters.—Brilliant white, four-sided flat prisms, becoming yellow by exposure to light; odourless; tasteless or feebly bitter. Scarcely soluble in cold water, freely in chloroform or in boiling spirit; insoluble in diluted mineral acids. Added to a warm alcoholic solution of potash it yields a violet-red. Santonin forms Santonates with alkalies, from which HCl liberates Santonic Acid, readily reconverted into Santonin.

Dose.—1 to 4 gr. for a child; 2 to 6 gr. for an adult.

Preparation.

Trochisci Santonini.—1 gr. in each. *Dose,* 1 to 6.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Santonin acts as a poison on the *Ascaris lumbricoides* or round worm, which infests the intestine; decidedly less on the *Oxyuris vermicularis* or thread-worm. It is used as an **anthelmintic** against the former parasite, combined with a purgative vermifuge, such as Pulvis Scammonii Compositus, or followed in a few hours by a laxative, such as Castor Oil.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Santonin is absorbed into the blood as sodium santonate; enters the tissues; and produces peculiar **disturbances of vision,** of the brain and spinal cord. Objects appear first blue and then yellow (chromatopsia); and finally colour vision is almost lost. **Consciousness is disturbed,** with a kind of intoxication, aphasia, tremors, and convulsions after large doses. Respiration is enfeebled, and the pulse reduced in frequency. Theso effects must be carefully avoided. Santonin is excreted by the kidneys as an obscure product of its oxydation in the system, which colours the (acid) urine greenish-yellow (alkaline urine red or purple), and causes some diuresis; also by the bowel. It has been used as an emmenagogue with various success.

Anthemidis Flores. — Chamomile Flowers. The dried single and double flower-heads or capitula of Anthemis nobilis. From cultivated plants.

Characters.—Single flowers have yellow tubular florets in the centre, surrounded by white and ligulate florets; in the double flowers all or nearly all the florets are white and ligulate; in both kinds the receptacle is solid, conical, densely covered with chaffy scales. Both varieties, especially the single, havo a strong aromatic odour, and very bitter taste.

Composition.—Chamomile Flowers contain 0·2 per cent. of the official *volatile oil,* and a *bitter extractive.*

Preparations.

1. **Extractum Anthemidis.**—A concentrated decoction, *with the addition of Oleum Anthemidis. Dose,* 2 to 10 gr.
2. **Infusum Anthemidis.**—1 in 20. *Dose,* 1 to 3 fl.oz. as a stomachic; 5 to 10 fl.oz. as an emetic.

From Anthemidis Flores is made :

Oleum Anthemidis.—The oil distilled in Britain from the Flowers.

Characters.—Pale blue or greenish-blue, becoming yellowish-brown; of characteristic odour and taste. It is composed of a terpene, $C_{10}H_{16}$, and an oxydised portion, $C_{10}H_{16}O_2$, which yields angelic acid, $HC_5H_7O_2$. *Dose,* 1 to 4 min.

ACTION AND USES.

Externally.—Warm infusions or decoctions of Chamomile, or the Flowers in bags soaked in hot water, possess the general properties of fomentations and poultices, the warm water being apparently the active constituent. They are much used as a domestic application to painful parts.

Internally.—Chamomile belongs to the class of **aromatic bitter stomachics.** The warm Infusion, freely drunk, is a mild simple emetic, which may be used in biliousness, ague, etc. The Oil or the Extract is usefully combined with purgative pills as a stomachic and carminative.

Taraxaci Radix. — DANDELION ROOT.

The fresh and dried roots of Taraxacum officinale. Collected in the autumn from indigenous plants.

Characters.—Fresh root a foot or more long, ½ an inch or more in diameter; smooth, yellowish-brown externally, whitish within. Fracture short; juice milky; the surface presenting faint concentric rings. Dried root shrivelled, deeply furrowed, dark brown or blackish; fracture short; exposed surface showing a yellow porous woody axis, and a thick whitish bark with irregular concentric rings. Inodorous; taste bitter. *Substance resembling Taraxacum :* Pellitory, pungent when chewed.

Composition.—Taraxacum Root contains an amorphous neutral principle *taraxacin ; potassium and calcium salts ; sugar ;* and *resinoid bodies,* which give the milky appearance to the juice. The relative richness of the constituents varies with the season and situation.

Preparations.

1. **Decoctum Taraxaci.**—1 of *dried* Root in 20. *Dose*, 2 to 4 fl.oz.
2. **Extractum Taraxaci.**—A *fresh* extract. 100 of *fresh* root in 8. *Dose*, 5 to 30 gr.
3. **Succus Taraxaci.**—Fresh juice, 3; Spirit, 1. *Dose*, 1 to 2 fl.dr.
4. **Extractum Taraxaci Liquidum.**—1, *dried*, in 1. *Dose*, $\frac{1}{4}$ to 2 fl.dr.

ACTION AND USES.

Taraxacum combines the properties of its two principal constituents, the bitter taraxacin and the alkaline salts, *i.e.* it is at once a simple **bitter** and a mild **laxative.** It is therefore indicated, and was formerly extensively given, in atonic dyspepsia attended by habitual constipation; and its preparations may be added to stomachic mixtures and laxative pills. Until recently Taraxacum was believed to be a cholagogue; but this effect, if it exist at all, appears to be indirect only.

Lactuca.—LETTUCE. The flowering herb of Lactuca virosa, a native of Britain.

Composition.—Extract of Lettuce contains a crystalline bitter principle, *lactucin*, $C_{22}H_{13}O_7$, and *lactucic acid*, of uncertain composition.

Preparation.

Extractum Lactucæ.—A *green* extract. 100 in 4. *Dose*, 5 to 10 gr.

ACTION AND USES.

Lactucin is slightly **hypnotic.** The Extract may cause some confusion of mind, headache, and diaphoresis; and acting as a mild sedative and **carminative** it makes an excellent pill basis for some purgatives, such as Calomel.

Arnicæ Rhizoma.—ARNICA RHIZOME. The dried rhizome and rootlets of Arnica montana. Collected in the mountains of middle and southern Europe.

Characters.—Cylindrical, dark brown, 1 to 2 inches or more long; $\frac{1}{6}$ to $\frac{1}{4}$ inch in diameter; contorted, rough from scars and remains of fallen leaves; giving off numerous, dark brown, filiform, wiry rootlets. Odour peculiar, aromatic; taste acrid, bitterish. *Substances resembling Arnica:* Valerian, known by odour; Serpentary, by odour; Veratrum Viride, by thicker rootlets.

Composition.—Arnica contains a small quantity of *volatile oil,* of complex composition, and said to yield *trimethylamin; tannic acid;* and an active resinous glucoside, *arnicin,* $C_{20}H_{30}O_4$.

Preparation.

Tinctura Arnicæ.—1 in 20. *Dose,* 1 to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Arnica, applied to the skin, sometimes causes hyperæmia, eczema, and even spreading erysipelas. It would, therefore, appear to **increase the activity of the circulation in the skin**; and the Tincture in water is a popular application to bruises, preventing swelling, and hastening the absorption of effused blood. It must be used with caution.

Internally.—Arnica is a **stimulant to the alimentary canal,** like volatile oils in general; in over-doses a powerful irritant, causing vomiting, pain, and purging, with consequent constitutional effects. Probably by reflex action from the stomach (see *Caryophyllum,* page 273), it stimulates the heart and circulation, the brain and spinal cord, in moderate doses; the pulse being strengthened, and symptoms of nervous debility removed. Arnica has, therefore, been used with success in low forms of fever, delirium tremens, and mental disorder.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

The active principles of Arnica enter the blood and thence the tissues, where its effects somewhat resemble those of Turpentine. If the dose be considerable, the reflex stimulant effect from the stomach is overcome by its **depressing** action on the **circulation and nerve centres**; headache, unconsciousness, and convulsions being induced, and the body temperature lowered. Arnica has thus been employed as an antipyretic, especially in acute rheumatism, but cannot be said to be used now.

3. REMOTE LOCAL ACTION AND USES.

Like its allies, Arnica is a remote stimulant of the kidneys and skin, and has been given in some cutaneous diseases such as eczema, and in chronic rheumatism.

LOBELIACEÆ.

Lobelia.—LOBELIA. The dried flowering herb of Lobelia inflata. Imported from North America.

Characters.—In compressed oblong rectangular packages,

$\frac{1}{2}$ to 1 lb. in weight, in sealed and labelled papers. Separate pieces of varying lengths, yellowish-green, angular; bearing hairy, oval, toothed leaves, some flowers, and fruits. Odour irritating. Taste at first mild; after chewing, burning and acrid.

Composition.—Lobelia contains *lobeline*, an oily, liquid, volatile alkaloid, with a pungent taste, and an odour like tobacco. *Lobelic acid* is united with the lobeline. *Incompatibles:* The caustic alkalies, which decompose lobeline.

Preparations.

1. **Tinctura Lobeliæ.**—1 in 8 of *Proof* Spirit. *Dose*, 10 to 30 min.
2. **Tinctura Lobeliæ Ætherea.**—1 in 8 of Spirit of Ether. *Dose*, 10 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Lobelia is a **gastro-intestinal stimulant**; in large doses an irritant, causing vomiting, pain, purging, and the ordinary symptoms of depression. It is not to be used as an emetic, but is sometimes useful in obstinate constipation.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

The active principles of Lobelia appear to enter the blood and tissues, where severe specific effects are produced by free doses, including general depression, muscular tremors and weakness, giddiness, headache, failure of the heart and breathing, and cold perspirations: a condition resembling collapse. The exact mode of action of the drug is not known. It appears to depress the convolutions secondarily only; to lower the activity of the motor centres in the cord, and cause muscular relaxation; to **depress the respiratory centre, and relax the bronchial muscles**; and to diminish the force of the heart and the tension of the vessels, after brief increase of the latter. Lobelia kills through the respiratory centre, like its ally Tobacco, and not through the heart.

Lobelia is a favourite remedy with some practitioners for the paroxysm of asthma, for which it should be given at the commencement in doses of 1 drachm of the Tincture, repeated every fifteen minutes till nausea is produced. In 10 min. doses, it is a useful addition to expectorant mixtures for bronchitis with spasm and very scanty tough sputum.

3. REMOTE LOCAL ACTION AND USES.

Lobeline is probably excreted by the kidneys and skin, and acts as a diuretic and diaphoretic. Except indirectly, these effects are not taken advantage of in medicine.

ERICACEÆ.

Uvæ Ursi Folia.—BEARBERRY LEAVES. The dried leaves of Arctostaphylos Uva-ursi. Indigenous.

Characters.—Very shortly stalked; obovate or spathulate; coriaceous; ½ to ¾ inch long; smooth and shining above, paler and minutely reticulated beneath; margins entire, slightly revolute. Odour tea-like when powdered; taste very astringent. *Substances resembling Uvæ Ursi Folia:* Senna and Buchu, q.v.

Composition.—Uva Ursi contains a bitter crystalline glucoside, *arbutin*, $C_{12}H_{16}O_7$, soluble in water, yielding glucose and a mixture of hydrochinon (*see* page 192) and methyl-hydrochinon; a second glucoside, *ericolin*, $C_{34}H_{56}O_{21}$; 33 per cent. of *tannic* and *gallic acids;* and a crystalline neutral body, *urson*. *Incompatibles.*—Iron, lead, and silver salts, alkaloids, gelatine.

Preparation.

Infusum Uvæ Ursi.—1 in 20. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Uva Ursi possesses much the same action as Pareira and Buchu, but it is more astringent in virtue of the tannic and gallic acids which it contains. The arbutin appears in the urine partly as hydrochinon-sulphuric acid. (*See* pages 191, 192.) Uva Ursi is used as a remote **astringent, stimulant, diuretic, and disinfectant,** in diseases **of the urino-genital tract,** such as chronic catarrh of the pelvis of the kidney, bladder, and urethra.

SAPOTACEÆ.

Gutta Percha.—GUTTA PERCHA. The concrete juice of Dichopsis Gutta, and of several other trees of the same natural order.

Characters.—Light-brown pieces, tough, flexible, plastic above 120° Fahr. Insoluble in water, alcohol, alkaline solutions, or dilute acids; almost entirely soluble in chloroform; entirely so in oil of turpentine, carbon disulphide, or benzol.

Composition. — Gutta Percha consists of hydrocarbons, usually slightly oxydised.

Preparation.

Liquor Gutta Percha.—1 dissolved in 8 of Chloroform; mixed with 1 of Carbonate of Lead; agitated; and decanted.

USES.

Gutta Percha is employed for making surgical instruments and apparatus. The Solution is used in Charta Sinapis.

STYRACACEÆ.

Benzoinum.—BENZOIN. A balsamic resin obtained by incisions in the bark of Styrax Benzoin, and other species of Styrax. Imported from Siam and Sumatra.

Characters.—Masses of tears loosely agglutinated, or closely compacted by a brown translucent substance. Tears in some specimens large and milk-white, the masses being almond-like; in others the white substance is very small, and the broken masses resemble reddish-brown granite. Benzoin is very brittle, but softens readily by warmth. Taste very little; odour, agreeable, balsamic. Soluble in spirit and in solution of potash. Gives off when heated fumes of Benzoic Acid.

Substances resembling Benzoin: Gum-resins and resins; distinguished by odour and taste.

Composition.—Benzoin contains 12 to 15 per cent. of the official *benzoic acid;* a trace of *cinnamic acid,* $C_9H_8O_2$; two *resins;* and a *volatile oil.*

Preparations.

1. **Adeps Benzoatus.**—1 to 50 of Prepared Lard.
2. **Tinctura Benzoini Composita.**—"Friar's Balsam." Benzoin, 8; Prepared Storax, 6; Balsam of Tolu, 2; Socotrine Aloes, about 1½; Spirit, 80. *Dose,* ½ to 1 fl.dr.
3. **Unguentum Cetacei.**—1 in 55.

From Benzoinum is made:

Acidum Benzoicum.—Benzoic Acid. $HC_7H_5O_2$. *Source.*—Prepared from Benzoin by sublimation. *Characters.*—Light feathery crystals, nearly colourless, with aromatic odour. *Solubility.*—1 in 400 of cold water, 1 in 12 of boiling water, 1 in 4 of spirit; soluble in solution of alkalies and lime. Phosphate of sodium or borax aids its solubility in water (1 of borax and 1 of acid soluble in 100 of water). Sublimed by heat. Solutions of Benzoates deposit the acid on addition of H_2SO_4. *Dose,* 10 to 15 gr.

Preparations.

a. TROCHISCI ACIDI BENZOICI.—½ gr. in each. *Dose,* 1 to 5.
b. TINCTURA CAMPHORÆ COMPOSITA.—2 gr. to 1 fl.oz. See *Opium.*

c. TINCTURA OPII AMMONIATA.—9 gr. to 1 fl.oz. See *Opium.*

From Acidum Benzoicum is made:

Ammonii Benzoas.—$NH_4C_7H_5O_2$. *Source.*—Made by dissolving Benzoic Acid in Solution of Ammonia and Water; evaporating (keeping Ammonia in excess); and crystallising. *Characters.*—Colourless laminar crystals, with the fragrant odour of Benzoic Acid. *Solubility.*—1 in 5 of water; 1 in 18 of spirit. Sublimes without residue. *Incompatibles.* —Persalts of iron, liquor potassæ, and acids. *Dose,* 10 to 20 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Benzoin and its preparations are **antiseptic and disinfectant**, and at the same time slightly **stimulant** to the vessels. The Compound Tincture, "Friar's Balsam," has long been used as an application to ulcers and foul wounds, and also to promote the healing of freshly incised wounds.

Internally.—Benzoin and its Acid cause sneezing and coughing when inhaled or applied in the solid form to the nose; much diluted with watery vapour, they are mild stimulants. The Compound Tincture is thus a useful substance for inhalation or spray in many laryngeal diseases; and Benzoic Acid has been applied direct to the affected surface in diphtheria, where it acts also as a disinfectant.

Taken by the mouth, Benzoic Acid causes slight heat and irritation in the region of the stomach; the Ammonium salt is much less irritant, and can be given in larger doses.

2. ACTION IN THE BLOOD, AND USES.

Benzoin and Benzoic Acid enter the blood in the form of benzoate of sodium, and here, as well as in the kidneys, the acid is **partly converted into hippuric acid** by combination with a molecule of glycocoll, thus: $C_7H_6O_2 + C_2H_5NO_2$ (glycocoll) $= C_9H_9NO_3$ (hippuric acid) $+ H_2O$. The exact source of the glycocoll is still obscure. It is not derived from the urea or uric acid, as was once suggested.

3. SPECIFIC ACTION AND USES.

Benzoic Acid and its salts act upon nutrition very much like the Salicylates, as far as they have been investigated; that is, they are **antipyretic**, whilst they are said to **increase metabolism**. They have been used to lower the temperature in fever, but are uncertain, and their effects frequently unpleasant.

4. REMOTE LOCAL ACTION AND USES.

Benzoic Acid is excreted by the kidneys, partly unchanged, partly as hippuric acid, and occasionally as succinic acid, increasing the flow of urine; by the skin and salivary glands, unchanged, stimulating their secretions; and probably by the respiratory organs, decidedly increasing the amount of expectoration. These remote local effects are turned to useful account. The Acid and its Ammonium salt are extremely valuable in inflammation of the bladder with alkalinity of the secretion and phosphatic deposits, by **acidulating the urine and stimulating and disinfecting the mucous surfaces.** As an **expectorant,** Benzoic Acid, chiefly as the Compound Tincture, or contained in Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, and the Balsams of Tolu and Peru, is very useful in chronic bronchitis, when the bronchial products are abundant, thick, possibly foul, the mucous membrane chronically inflamed and weak, and reflex activity low.

OLEACEÆ.

Oleum Olivæ.—OLIVE OIL. The oil expressed in the south of Europe from the ripe fruit of Olea europæa.

Characters.—Pale yellow, with a very faint agreeable odour, and a bland oleaginous taste; congeals partially at 36° Fahr.

Composition.—Olive Oil consists of 72 per cent. of a fluid oil, *olein*, $C_3H_5,3C_{18}H_{33}O_2$, and 28 per cent. of a solid oil or stearoptene, *palmitin*, $C_3H_5,3C_{16}H_{31}O_2$. These are compounds of a radical, *glyceryl*, C_3H_5, with *oleic acid*, $HC_{18}H_{33}O_2$, and *palmitic acid*, $HC_{16}H_{31}O_2$, respectively. *Dose*, $\frac{1}{2}$ to 1 fl.oz.

Preparations.

Many Emplastra, Linimenta, Unguenta, Enema Magnesii Sulphatis, and Charta Epispastica. It is also the source of Hard and Soft Soaps and of Glycerine.

Sapo Durus.—Hard Soap. Sodium Oleate. Made with Olive Oil and Soda. $C_3H_53C_{18}H_{33}O_2 + 3NaHO = 3NaC_{18}H_{33}O_2 + C_3H_5(HO)_3$.

Preparations.

a. **Linimentum Saponis.**—16, with Camphor, 8; Oil of Rosemary, 3; Spirit, 128; Water, 32.

Linimentum Saponis is contained in Linimentum Opii.

b. **Pilula Saponis Composita.**—Opium, 1; Hard Soap, 4; Water; q.s. *Dose*, 3 to 5 gr. See *Opium*.

Sapo Durus is also used in the preparation of many other pills.

Sapo Mollis.—Soft Soap. Potassium Oleate. Made with Olive Oil and Potash.

Sapo Mollis is contained in Linimentum Terebinthinæ.

[**Sapo Animalis**, Curd Soap, is made with *Animal* fat. *See* page 408.]

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, Olive Oil renders the skin smoother, softer, and more flexible. It is used to facilitate friction over enlarged bones, or stiff joints; and in the form of liniments, to bring active bodies, such as Ammonia and Lime, more thoroughly into contact with the surface in a mild form. It is also an excellent **mechanical application** to burns and certain skin diseases, by coating the surface and excluding air, and in the treatment of the effects of corrosive acids and alkalies. Inunctions with Olive Oil to which $\frac{1}{20}$ part of Carbolic Acid has been added, are ordered in the desquamative stage of scarlet fever as a disinfectant measure, but are of doubtful value. Oil rubbed into the skin is absorbed by the lymphatics, and has a distinctly **nutritive** effect, of which use may be made in wasted children when the stomach rejects food.

Internally, Oils may be similarly given in corrosive poisoning. In the stomach they are not specially changed; in the intestines they are partly emulsified, partly saponified, their glycerine being set free, and their fatty acids combining with free alkalies to form soaps. The molecular basis of the chyle is increased by this emulsion and soapy compound. With many persons excess of Oil causes dyspepsia and loathing, especially in warm weather; with most subjects some relaxation of the bowels or diarrhœa. As an enema, Olive Oil is **laxative**, and is used in obstruction of the bowels.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Olive Oil enters the blood from the lacteals or lymphatics and may be traced in it if given in excess. Thence it reaches all the cells of the body, especially those of the connective tissues, the amount varying with a number of circumstances. Here it is fully oxydised into carbonic acid and water, and constitutes a **food**, increasing the amount of fat in the tissues, furnishing force, and thus saving the waste of nitrogenous tissue, and the necessity of consuming quantities of nitrogenous food, but unable of itself to support life.

Oils and fats are used in many forms (Olive and other vegetable oils, Butter, Cream, Cod-liver Oil, etc.), in wasting diseases, such as scrofula and phthisis, as is fully discussed under *Oleum Morrhuæ*, page 414. Olive Oil is rarely used in this country, but may be taken by some patients, in the form of Sardine Oil, when Cod-liver Oil is rejected.

Oils are excreted as carbonic acid and water, but excess will appear unchanged in the urine. It is not a special renal irritant like Linseed Oil.

Glycerinum.—GLYCERINE. $C_3H_5(HO)_3$. A sweet principle obtained by reaction of fats and fixed oils with aqueous fluids, and containing a small percentage of water.

Characters.—A clear colourless fluid, oily to the touch; without odour; of a sweet taste; freely soluble in water and in alcohol; a free solvent of many substances. Sp. gr., 1·250. It is the trihydroxyl derivative, or alcohol, of a hydrocarbon radical glyceryl, C_3H_5, which, in combination with fatty acids, forms fixed oils. It is separated in the hydrated form when oils are decomposed by alkaline hydrates (saponification), or by water (hydrogen hydrate) at high temperatures. Glycerine is thus a by-product in making soaps and lead plaster. (*See* pages 314 and 61.)

Impurities: Free acid or alkali; various salts; formic or butyric acid; other organic matters. *Dose,* 1 to 2 fl.dr.

Preparations.

1. **Glycerinum Acidi Carbolici.**—4 to 1.
2. **Glycerinum Acidi Gallici.**—4 to 1, gently heated.
3. **Glycerinum Acidi Tannici.**—4 to 1, gently heated.
4. **Glycerinum Aluminis.**—5 to 1, gently heated.
5. **Glycerinum Amyli.**—5 to 1, with 3 of Water; heated until a jelly is formed.
6. **Glycerinum Boracis.**—4 to 1, with 2 of Water, heated.
7. **Glycerinum Plumbi Subacetatis.**—See *Plumbum,* page 62.
8. **Glycerinum Tragacanthæ.**—4 to 1, with $\frac{2}{3}$ Water.
9. LINIMENTUM POTASSII IODIDI CUM SAPONE. *See* page 124.
10. MEL BORACIS. *See* page 146.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Glycerine is a slightly **stimulant, antiseptic, hygroscopic,** and adhesive substance, which forms a useful addition to lotions and other applications for the skin, where a desiccant effect is not undesirable. For the same reason it is unsuitable when the skin is already too dry and brittle. Its remarkable powers as a solvent, and mechanically, also render it invaluable in lotions.

Glycerine is readily absorbed by the unbroken skin, and will carry in with it alkaloids or other active substances, such as the atropine in Extract of Belladonna.

Internally.—Glycerine is **very sweet**, and imparts a smooth sweet agreeable taste to nauseous or astringent mixtures, rendering the addition of sugar unnecessary. As a topical stimulant and demulcent, it is an excellent vehicle for such applications for sore throat as Tannic Acid. In the stomach it produces no special effect; but is a laxative when freely given.

2. ACTION ON THE BLOOD.

Glycerine is freely absorbed by all surfaces, and is one of the normal products of the digestion of oils and fats in the intestines. In large quantity it is said to cause the solution of the red corpuscles, the diffusion of the hæmoglobin in the plasma, and consequent hæmoglobinuria.

3. SPECIFIC ACTION AND USES.

Glycerine has been supposed to be **nutritive**, and may contribute to the formation of adipose tissue, as a portion of the fats and oils of food must be decomposed in digestion, and the glyceryl again united with the fatty acid in the process of nutrition. The results obtained from the administration of Glycerine instead of oils in phthisis have been very divergent, and on the whole not encouraging. The same may be said of its use in diabetes.

4. REMOTE LOCAL ACTION AND USES.

Glycerine is decomposed in the system, and passes out as propionic, formic, and other acids. The urine of persons taking Glycerine contains a reducing body which gives the copper and fermentation tests for sugar, but is not sugar.

Acidum Oleicum.—OLEIC ACID. $HC_{18}H_{33}O_2$. A fluid fatty acid, usually not quite pure.

Source.—Made in the saponification of olein, or by the action of superheated steam on fats, with subsequent separation from solid fats by pressure. (*See* page 314.)

Characters.—A straw-coloured liquid, nearly odourless and tasteless; and with only a very faint acid reaction. Exposed to air it becomes brown and acid. Sp. gr. 0·860 to 0·890. It becomes semisolid at 40° Fahr. *Solubility:* Insoluble in water, readily soluble in alcohol, chloroform, and ether. *Impurities:* Stearic and palmitic acids, giving, with acetate of lead, a precipitate insoluble in ether.

Preparations.

1. **Oleatum Hydrargyri.**—9 to 1. *See* page 95.
2. **Oleatum Zinci.**—9 to 1. *See* page 70.

From Zinci Oleatum is prepared:

UNGUENTUM ZINCI OLEATI. *See* page 70.

ACTION AND USES.

Oleic Acid **penetrates the skin** more readily and thoroughly than fixed oils or fats, entering the cutaneous tissues not through the vessels, but through the natural openings, by which it reaches the follicles. It is therefore employed as a solvent and vehicle of active remedies for application to the skin, in the form of Oleates, a number of which are now employed as well as the two that are official.

Manna.—MANNA. A concrete saccharine exudation obtained by making transverse incisions in the stems of cultivated trees of Fraxinus Ornus. From Calabria and Sicily.

Characters.—In stalactiform pieces, 1 to 6 inches long, and 1 or 2 inches wide; uneven, porous, crystalline, friable, curved on one side; yellowish-brown; odour faint, like honey; taste sweetish, acrid and bitter. Solubility, 1 in 6 of water.

Composition.—Manna consists principally of 70 per cent. of a peculiar sugar, *mannite*, $C_6H_8(HO)_6$, cane sugar, and indefinite matter. Mannite does not undergo much vinous fermentation. *Dose*, 60 gr. to 1 oz.

ACTION AND USES.

Manna is a mild **laxative**, given to children for constipation, because not unpleasant, and easily dissolved in milk.

LOGANIACEÆ.

Nux Vomica. NUX VOMICA.—The seeds of Strychnos Nux vomica. Imported from the East Indies.

Characters.—Rounded; $\frac{7}{8}$ to 1 inch or more in diameter;

about $\frac{1}{4}$ inch thick; flattish or concavo-convex, rounded at the margin. Marked on one surface by a central scar, whence a projecting line passes to the margin, ending in a slight prominence. Externally ash-grey, glistening with short satiny hairs; internally horny, somewhat translucent. No odour; taste extremely bitter.

Composition.—Nux Vomica seeds contain two alkaloids: ·2 to ·5 per cent. of *strychnine,* which is official, and ·12 to 1·0 per cent. of *brucine,* united with a crystalline acid, *strychnic* or *igasuric acid.*

Brucine, $C_{23}H_{26}N_2O_4$, occurs in colourless prisms, pearly flakes, or masses. It is soluble in alcohol; much more soluble in water, less bitter, 38 times weaker, and 3 times slower physiologically than Strychnine. It gives a red colour with HNO_3.

Preparations.

Extractum Nucis Vomicæ.—Made by extracting with Spirit and Water, and evaporating to a definite strength, viz. 15 per cent. of total alkaloids. *Dose,* $\frac{1}{4}$ to 1 gr.

From Extractum Nucis Vomicæ is prepared:

Tinctura Nucis Vomicæ.—Extract, 133 gr.; Spirit, 16 fl.oz.; Water, 4 fl.oz. 1 gr. of alkaloids in 1 fl.oz. *Dose,* 5 to 20 min.

From Nux Vomica is made:

Strychnina.—Strychnine. $C_{21}H_{22}N_2O_2$. *Source.*—Made from the seeds of Nux Vomica by (1) adding a solution of Acetate of Lead to a concentrated tincture, so as to precipitate the colouring matter, etc., and filtering; (2) concentrating the filtrate by evaporation, and adding Ammonia, to precipitate the alkaloids; (3) washing the precipitate and dissolving it in boiling Spirit, and crystallising out the Strychnine by evaporation and cooling from the Brucine which remains in solution; and (4) purifying by repetition of process (3). *Characters.*—Very small colourless prisms, inodorous, intensely bitter (but not to be tasted by the student except in very weak solutions). *Solubility.*—1 in 6,500 of cold, 1 in 2,500 of hot water; readily in boiling, but not in cold, spirit; readily in chloroform; soluble in ether. Pure sulphuric acid forms with it a colourless solution, which on the addition of bichromate of potassium acquires an intensely violet hue, speedily passing through red to yellow. Not coloured by nitric acid. Causes convulsions in animals. *Impurity.*—Brucine. *Dose,* $\frac{1}{30}$ gr., gradually increased to $\frac{1}{12}$ gr., always in solution.

Preparation.

LIQUOR STRYCHNINÆ HYDROCHLORATIS.—4½ gr. to 1 fl.oz. of Spirit, Water, and Diluted Hydrochloric Acid. 1 in 100. *Dose*, 5 to 10 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally.—Strychnine is a powerful antiseptic, but is too poisonous to be applied to wounds.

Internally.—Nux Vomica and Strychnine possess all the properties of **bitters** described under *Calumba* (page 204). Their use is not different from that of other bitters, excepting that whilst unpleasant from the intensity and persistency of their taste and the absence of flavour, they are very convenient on account of their small bulk.

Strychnine is believed to **increase the peristaltic action** of the intestines, and is given with purgatives, especially Aloes, in chronic constipation from atony of the bowels.

2. ACTION ON THE BLOOD.

Strychnine enters the blood from mucous surfaces, or when given hypodermically. Here it affects both the red corpuscles and the plasma, reducing the absorptive power of the former for oxygen, and the discharge of carbonic acid from the latter. These effects are not, however, the cause of the specific action of the drug immediately to be described.

3. SPECIFIC ACTION.

Strychnine quickly finds its way into the viscera, especially the nervous system ; and is peculiar in remaining so long within them, that it is not wholly excreted before several days. Entering rapidly, and disappearing slowly, the alkaloid accumulates in the body if the dose, however small, be very frequently repeated, and is said to have a "cumulative action."

In medicinal doses, Strychnine produces a **tonic** influence, as described under Calumba and Quinine, with a sense of increased strength and spirits. Therewith its specific action is soon developed, namely, increased sensibility of touch, sight, and hearing, with some disorder of the senses, such as of colour, vision, and smell. Repeated or larger doses next lead to sudden twitchings of the muscles of the limbs, a constricted feeling in the chest and some dysphagia, with a sense of anxiety. Poisonous doses produce **violent convulsions**, and rapid death by exhaustion and asphyxia from spasmodic arrest of the respiratory muscles. The phenomena resemble tetanus, but differ from it in the complete relaxation of the muscles between the convulsive seizures, in the great rapidity of their course, and in the comparative absence of trismus (lock-jaw).

Careful analysis resolves the phenomena of Strychnine poisoning as follows, and enables us to understand its action in medicinal doses: The *convolutions* are unaffected. The **motor centres of the cord are powerfully irritated** by toxic doses, and this in such a way that their **reflex excitability is enormously increased.** The very slightest stimulation of the skin, such as a breath of air, a loud sound, or a bright light, is sufficient to originate reflex muscular spasms. The muscles of respiration are manifestly involved in this effect, and the vigour of their action greatly increased; and this is carried so far that they remain contracted in inspiration, and give rise to asphyxia.

The *medulla* is stimulated by Strychnine in all its important centres. The **respiratory centre is increased in activity,** and transmits powerful influences downwards to the already excited cord, thus causing increased frequency and depth of the movements of the chest. The *cardiac* centre and the cardiac ganglia and nerves appear to be stimulated by Strychnine, but the violent contractions of the voluntary muscles completely modify the direct effect of the alkaloid, which is said actually to cause slowing of the heart (in animals paralysed by curare). Death does not occur through the heart, which beats after respiratory death and remains contracted. The *vaso-motor* centre is increased in vigour, an effect which is heightened by the muscular spasm, and finally by the asphyxial state of the blood: thus the pressure rises enormously for a time.

The *motor nerves and muscles* are comparatively unaffected by Strychnine; its local application in moderate doses stimulates them. The same may be said of the *sensory nerves*, vision being improved by injections of Strychnine in the temple, which appear to cause contraction of the retinal cones. The *body temperature* naturally rises during the convulsions.

4. SPECIFIC USES.

Strychnine is indicated in paralysis, especially paralysis from disease or disorder of the cord, but is not of much real service in this class of cases. Its function in cerebral disease is mainly to sustain the activity of the spinal centres, nerves, and muscles until the higher centres are restored; but electricity has almost entirely displaced it for this purpose. It appears, however, to be useful in so-called "reflex," or "functional," paralysis; in diphtheritic paralysis; and in *peripheral* paralysis (of the fore-arm, eyes, larynx, sphincters, etc.)

often toxic in origin, *e.g.* due to lead, tobacco, or alcohol. For these local cases Strychnine is best given in the form of hypodermic or intramuscular injection ($\frac{1}{48}$ gr. of Sulphate of Strychnine in 10 min. of distilled water). In sensory paralysis Strychnine is useless, but it appears to relieve some forms of blindness (amaurosis) when applied locally, *i.e.* hypodermically in the temple. In chronic nervous disorders, such as chorea, epilepsy, neuralgia, and asthma, it is of benefit as a bitter stomachic and tonic, an effect more generally available than the specific action of the drug.

As a respiratory stimulant, strychnine may be used in bronchitis, emphysema, and phthisis, to increase the vigour both of the respiratory centre and the respiratory movements. It is advantageously combined with expectorants, its tonic action being further useful. From its stimulant and tonic action on the heart and vessels, it is given with benefit in cardiac dilatation with low pressure.

Strychnine is a physiological antagonist of Chloral, Morphine, and Physostigmine, and may be given in moderate doses in poisoning by these substances, whilst all the ordinary methods of recovery are persevered in.

5. REMOTE LOCAL ACTION.

Strychnine is excreted in the urine, sweat, and saliva, as we have seen, very slowly. The practical importance of this fact has already been insisted on.

Spigeliæ Radix.—CAROLINA PINK. (*Not official.*) The rhizome and rootlets of Spigelia marilandica. From the United States.

Characters and Composition.—A thick globular brown head, with numerous fine branching rootlets. Contains a *bitter principle*, a *volatile oil, tannin*, etc. *Dose*, 60 to 120 gr.

ACTION AND USES.

Spigelia is an **anthelmintic**, and is directed against the round worm, in the form of a fluid extract, in doses of 1 to 4 fl.dr. It is moderately **purgative**, but should be assisted by Senna or other cathartic.

Gelsemium. — YELLOW JASMINE. The dried rhizome and rootlets of Gelsemuim nitidum. From the United States.

Characters.—Nearly cylindrical; $\frac{1}{2}$ to 6 inches or more long; $\frac{1}{4}$ to $\frac{3}{4}$ inch in diameter; with small rootlets attached or not; light yellowish-brown externally, with dark purplish longitudinal lines; fracture splintery. Bark thin, with silky fibres in its liber, closely attached to a pale yellow porous woody axis, with medullary rays, with or without pith. Odour narcotic, aromatic; taste bitter.

Composition.—Gelsemium contains a powerful alkaloid *gelsemine, gelseminic acid*, a *volatile oil*, and other ingredients. *Dose*, 5 to 30 gr.; *of gelsemine*, $\frac{1}{60}$ to $\frac{1}{20}$ gr.

Preparations.

1. **Extractum Gelsemii Alcoholicum.**—Spirituous and aqueous. *Dose*, $\frac{1}{2}$ to 2 gr.
2. **Tinctura Gelsemii.**—1 in 8 of *Proof* Spirit. *Dose*, 5 to 20 min.

ACTION AND USES.

Gelsemium is a **powerful depressant** of the motor parts of the cord, causing paralysis, which is followed later by sensory depression and anæsthesia. Respiration fails, and death occurs by asphyxia. The heart is also depressed; the skin is stimulated. The pupil is dilated, and the ocular and levator palpebræ muscles are paralysed, all through the third nerve.

Gelsemium has been given in tetanus, asthma, whooping-cough, and other convulsive diseases with uncertain results. It appears to relieve some cases of neuralgia. In sick headache it may produce great relief, if the dose be pushed.

APOCYNACEÆ.

Quebracho Bark. (*Not official.*)—The bark of Aspidosperma Quebracho. From Chili.

Characters.—In pieces, $\frac{3}{4}$ inch thick; interior fibrous, cinnamon-brown, with short fracture; exterior reddish ochre, warty; taste bitter, slightly aromatic, unpleasant.

Composition.—Quebracho Bark and Wood contain an alkaloid, *aspidospermine*, $C_{22}H_{30}N_2O_2$, soluble in spirit, and three other alkaloids. The wood contains much tannin.

ACTION AND USES.

Quebracho and its alkaloids **reduce the frequency of respiration** through the centre; the heart's action through the intrinsic ganglia; the sense of dyspnœa induced by exercise;

and the body temperature. A Tincture of the Bark (1 to 5) in doses of 5 min. to 1 fl.dr., has been used with success in some cases of disease attended by dyspnœa, especially emphysema, but the drug is uncertain and should be given with caution.

Strophanthi Semina.—STROPHANTHUS SEEDS. (*Not official.*) The seeds of Strophanthus (? hispidus), (S. Kombé), a woody climber. From Equatorial Africa.

Characters.—Seeds oval, arrow-like with comose appendices, weighing about $\frac{1}{2}$ grain, contained to the number of 100 to 200 in long follicles.

Composition.—The active principle is a glucoside *strophanthin*, crystalline, very bitter, feebly acid, very soluble in water and in spirit; with fat and colouring matter.

Non-official Preparations.

1. TINCTURA STROPHANTHI.—1 in 8. *Dose*, 3 to 20 min.
2. Watery and Alcoholic Solutions of Strophanthin. *Dose*, $\frac{1}{50}$ gr. of Strophanthin hypodermically.

ACTION AND USES.

Strophanthus is closely allied to Digitalis in its action on the circulation (*see* page 341), and has been recently introduced as a **cardiac stimulant** and **diuretic** in the same class of cases. It appears to exert a much more powerful action on the heart than Digitalis, and a less powerful action on the vessels; whilst it is less irritant to the alimentary canal, and does not tend to accumulate in the system.

ASCLEPIADACEÆ.

Hemidesmi Radix.—HEMIDESMUS ROOT. The dried root of Hemidesmus indicus. From India.

Characters.—Cylindrical, twisted, longitudinally furrowed pieces, 6 inches or more long; with a thin yellowish-brown corky layer, easily separated from the other portion of the bark, which often has annular cracks. Odour fragrant; taste sweetish, very slightly acid.

Substances resembling Hemidesmus: Sarsaparilla, Ipecacuanha, Senega. Hemidesmus has cracks.

Composition.—Hemidesmus is believed to contain *hemidesmic acid*, a volatile crystallisable substance.

Preparation.

Syrupus Hemidesmi.—4 in 42. *Dose*, 1 fl.dr.

ACTION AND USES.

Hemidesmus is used in India as an **alterative** in lieu of Sarsaparilla. The same obscurity exists respecting the action and value of this as of the other drug. See *Sarsæ Radix*, page 389.

GENTIANACEÆ.

Gentianæ Radix.—GENTIAN ROOT. The dried root of Gentiana lutea. Collected in the mountainous districts of central and southern Europe.

Characters.—In cylindrical pieces or longitudinal slices, a few inches to a foot or more long, $\frac{1}{2}$ to 1 inch thick; with annular wrinkles when from the upper part of the root, and longitudinal furrows. Deep yellowish-brown externally; reddish-yellow within; tough and brittle. Bark thick, reddish, separated from the spongy central woody portion by a dark-coloured cambium zone. Odour heavy, peculiar; taste sweetish, ultimately very bitter.

Composition.—Gentian contains ·1 per cent. of a bitter glucoside, *gentiopicrin*, $C_{20}H_{30}O_{12}$, crystalline, readily soluble in water and dilute spirit, yielding by decomposition glucose and *gentiogenin*. This is united with an inert non-bitter body, *gentianic acid*, *sugar*, *gum*, and a trace of a *volatile oil*. *Incompatibles:* Sulphate of iron, nitrate of silver, and lead salts.

Preparations.

1. **Extractum Gentianæ.**—Aqueous. *Dose*, 2 to 5 gr.
2. **Infusum Gentianæ Compositum.**—1; Bitter Orange Peel, 1; Fresh Lemon Peel, 2; Boiling Water, 80. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Gentianæ Composita.**—6; Bitter Orange Peel, 3; Cardamoms, 1; Proof Spirit, 80. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

Gentian possesses the action of other **bitters**, as described under *Calumbæ Radix*. The uses made of it correspond. It is perhaps the most extensively used and popular of all bitters, because (1) it is agreeable, being very slightly **aromatic**; (2) its bitter is not intense, and its astringency but slight; and (3) it is more stimulant to the bowels, and more disinfectant than some bitters. A drawback to its usefulness is the liability of the sugar which it contains to ferment in simple infusions.

Chirata.—CHIRETTA. The dried plant, Ophelia Chirata. Collected in Northern India when the fruit begins to form.

Characters.—Root 2 to 3 inches long, usually unbranched. Stem 3 feet or more long, rounded below, quadrangular above, branched dichotomously, smooth, orange-brown or purplish. Leaves ovate, 5 to 7-ribbed; flowers small, numerous, panicled. No odour; taste very bitter. Stem, except below, consists of a thin woody ring, enclosing a large yellowish pith. *Impurity:* Munjeet (Rubia cordifolia); without pith and the leaves petiolate. *Substance resembling Chiretta:* Lobelia; not bitter.

Composition.—Chiretta contains an active bitter principle, *chiratin*, combined with *ophelic acid.*

Preparations.

1. **Infusum Chiratæ.**—1 in 40 of Water at 120° Fahr. *Dose,* 1 to 2 fl.oz.
2. **Tinctura Chiratæ.**—1 in 8 of *Proof* Spirit. *Dose,* $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

Chiretta is an **aromatic bitter,** almost identical in its action and uses with Gentian; but may be given with Iron.

CONVOLVULACEÆ.

Scammoniæ Radix.—SCAMMONY ROOT. The dried root of Convolvulus Scammonia. From Syria and Asia Minor.

Characters.—Of varying lengths and sizes; cylindrical, except above, where it is enlarged, with remains of the slender aërial stems; shrivelled; longitudinally furrowed. Greyish-brown or yellowish externally; pale brown or whitish within; with small fragments of pale yellowish-brown resin on a fractured surface. Odour and taste faint, somewhat like Jalap.

Substance resembling Scammony Root: Belladonna Root, which is smaller.

Scammonium.—SCAMMONY. A gum resin, obtained by incision from the living root of Convolvulus Scammonia, hardened in the air.

Characters and tests.—Flattish irregular cakes of varying sizes; ash-grey or blackish-brown externally, sprinkled with a greyish-white powder. Very brittle; fracture resinous, shining, porous, uniformly dark greyish-black. Odour peculiar, cheesy. When chewed it causes a slight pricking sensation in the back of the throat. *Impurities:* Chalk and starch. .

Composition.—Scammony contains 75 per cent. of the official *resin*, and 10 to 20 of *gum*. The root, the gum-resin, and the resin contain an active glucoside, *scammonin*, $C_{34}H_{56}O_{16}$, identical with Convolvulin. (*See* Jalapa, page 328.) *Dose*, 5 to 10 gr.

Preparation.

Mistura Scammonii.—3 gr. triturated in 1 fl.oz. of Milk. *Dose*, 1 to 3 fl.oz.

From Scammoniæ Radix or Scammonium is made:

Scammoniæ Resina.—RESIN OF SCAMMONY.

Source.—Made from Scammony Root (or from Scammony) by preparing a tincture, precipitating this in water, washing and drying.

Characters.—Brownish translucent pieces, brittle, resinous in fracture, of a sweet fragrant odour if prepared from the Root; soluble in ether. *Impurities:* Guaiacum Resin, giving blue with potato; Jalap Resin, insoluble in ether. *Dose*, 3 to 8 gr.

Preparations of the Resin.

1. **Confectio Scammonii.**—48; Ginger, 24; Oil of Caraway, 2; Oil of Cloves, 1; Syrup, 48; Honey, 24. *Dose*, 10 to 30 gr.
2. **Pulvis Scammonii Compositus.**—4; Jalap, 3; Ginger, 1. *Dose*, 10 to 20 gr.
3. **Pilula Scammonii Composita.**—1; Resin of Jalap, 1; Curd Soap, 1; Strong Tincture of Ginger, 1; Spirit, 2. This is the only aperient pill in the vegetable materia medica that does not contain Aloes. *Dose*, 5 to 15 gr.

Scammoniæ Resina is also an important ingredient of Extractum Colocynthidis Compositum (about 1 in 6), Pilula Colocynthidis Composita (1 in 3), and Pilula Colocynthidis et Hyoscyami (1 in 4½).

ACTION AND USES.

Preparations of Scammony are powerful **stimulants of the intestinal glands,** and to a less degree of the **liver,** causing free purgation within a few hours, attended by griping. Scammony begins to act in the duodenum on meeting the bile, and will not purge if injected into the blood.

Scammony is used chiefly as a smart **purgative and anthelmintic** in children, in cases unattended by irritation of the stomach and bowels. As a hydragogue, Jalap is preferred.

Jalapa.—JALAP. The dried tubercles of Ipomœa Purga. Imported from Mexico.

Characters.—Usually irregularly oblong or napiform; hard; compact; varying in size; the larger cut into halves or quarters. Externally dark brown, wrinkled, with paler scars. Internally dirty-yellowish or brownish; with dark brown irregular circles. Odour faint, peculiar, smoky; taste sweetish, acrid, nauseous.

Composition.—Jalap contains 15 to 20 per cent. of the official *resin*. This is composed of two glucosides, *convolvulin*, $C_{34}H_{56}O_{16}$, and *jalapin*, $C_{31}H_{50}O_{16}$. *Dose*, 10 to 30 gr.

Preparations.

1. **Extractum Jalapæ.**—Spirituous and aqueous. 2 in 1. *Dose*, 5 to 15 gr.
2. **Pulvis Jalapæ Compositus.**—Jalap, 5; Acid Tartrate of Potassium, 9; Ginger, 1. *Dose*, 20 to 60 gr.
3. **Tinctura Jalapæ.**—1 in 8 of *Proof* Spirit. *Dose*, ½ to 2 fl.dr.

Jalap is also an important ingredient of Pulvis Scammonii Compositus.—3 in 8.

From Jalapa is made:

Jalapæ Resina.—Resin of Jalap.

Source.—Made by precipitating a tincture of Jalap in water; washing, and drying.

Characters.—Dark-brown opaque fragments, translucent at the edges; brittle, with a resinous fracture; odour sweetish; taste acrid; readily soluble in spirit, insoluble in water. *Substance resembling Resin of Jalap:* Aloes, which is bitter. *Dose*, 2 to 5 gr.

Resin of Jalap is contained in Pilula Scammonii Composita.

ACTION AND USES.

The action of Jalap closely resembles that of Scammony, but it is less irritant or likely to gripe. Like it, Jalap does not purge unless in the presence of the duodenal fluids; it is also a powerful **stimulant of the intestinal secretion**, less so of the bile. Small doses produce a laxative effect; large doses act within two hours, causing several watery stools, attended by some pain unless the drug be combined with carminatives.

Jalap is extensively used in the form of the Compound Powder, as a **hydragogue** purgative to drain off water by the bowel in dropsy, and occasionally as an ordinary smart purgative. The Resin in small doses may be used in laxative pills for habitual constipation. As an **anthelmintic**, Jalap occurs in Pulvis Scammonii Compositus. This drug must be avoided when the alimentary canal is inflamed or irritable.

SOLANACEÆ.

Capsici Fructus.—CAPSICUM FRUIT. The dried ripe fruit of Capsicum fastigiatum. Imported from Zanzibar, and distinguished in commerce as Guinea Pepper and Pod Pepper.

Characters.—From $\frac{1}{2}$ to $\frac{3}{4}$ inch long, and $\frac{1}{4}$ inch in diameter; shrivelled; oblong-conical; composed of a dull orange-red, smooth, shining, brittle, translucent pericarp, enclosing several small roundish flat seeds. Taste of pericarp and seeds intensely pungent; odour peculiar, pungent.

Composition.—Capsicum yields an acrid non-alkaloidal body *capsaicin*, $C_9H_{14}O_2$; a volatile alkaloid *capsicine*; an *oleo-resin*; and fatty matter. *Impurities.*—Red lead and other coloured substances. *Dose*, $\frac{1}{2}$ to 1 gr.

Preparation.

Tinctura Capsici.—1 in 27. *Dose*, 2 to 10 min.

ACTION AND USES.

Capsicum has a comparatively powerful local action, closely resembling that of volatile oils; and may be applied as a stimulant and counter-irritant. *Internally*, it is used as a **condiment** (cayenne pepper); and medicinally in stimulant gargles, and as a **pungent stomachic, carminative and stimulant**, to dispel flatulence and rouse the appetite, especially in alcoholic subjects.

ATROPACEÆ.

Belladonnæ Folia. — BELLADONNA LEAVES. The fresh leaves, with the branches to which they are attached, of Atropa Belladonna; also the leaves separated from the branches and carefully dried; gathered when the fruit has begun to form, from wild or cultivated British plants.

Characters.—Leaves alternate below, in pairs above of unequal size; shortly stalked; 3 to 8 inches long; broadly ovate, acute, entire, smooth. The expressed juice, or an infusion, dropped into the eye, dilates the pupil.

Substances resembling Belladonna Leaves: Stramonium Leaves, more wrinkled; Hyoscyamus Leaves, which are hairy.

Belladonnæ Radix.—BELLADONNA ROOT. The root of Atropa Belladonna, from plants growing wild or cultivated in Britain, and carefully dried; or imported in a dried state from Germany.

Characters.—Rough, irregular, branched pieces, from 1 to 2 feet long, ½ to 2 inches thick; marked above by the hollow bases of the stems; with a dirty grey or brownish integument, easily scraped off, exposing a whitish surface. Fracture short; and the surface is then seen to consist of a thin yellowish or pale brown cortex, separated by a dark line from a large central brownish portion, marked throughout by scattered darker-coloured dots, without evident rays. *Substances resembling Belladonna Root:* Pyrethrum and Scammony Root, *q.v.*

Composition.—Belladonna Root and Leaves contain two alkaloids: (1) ·06 to ·3 per cent. of the official *atropine;* and (2) *belladonnine, homologous* with atropine, and probably *identical* with hyoscyamine, daturine, and duboisine. These alkaloids exist as malates in the plant.

Preparations.

A. *Of Belladonnæ Folia:*

1. **Extractum Belladonnæ.**—A *green* extract. 4 from 100 of *fresh* Leaves. *Dose,* ¼ to 2 gr.
2. **Succus Belladonnæ.**—Juice, 3; Spirit, 1. *Dose,* 5 to 15 min.
3. **Tinctura Belladonnæ.**—1 of *dried* Leaves in 20 of *Proof* Spirit. *Dose,* 5 to 30 min.

B. *Of Belladonnæ Radix:*

1. **Extractum Belladonnæ Alcoholicum.**—Spirituous and aqueous. *Dose,* $\frac{1}{16}$ to ¼ gr.

   From the Alcoholic Extract are prepared:

   a. EMPLASTRUM BELLADONNÆ.—Extract, 4; Resin Plaster, 8; Soap Plaster, 8.
   b. UNGUENTUM BELLADONNÆ.—1 to 9 of Benzoated Lard.

2. **Linimentum Belladonnæ.**—1 oz. to 1½ fl.oz. of Spirit, with $\frac{1}{20}$ of Camphor.

From Belladonnæ Radix is made:

3. **Atropina.**—Atropine. Atropia. $C_{17}H_{23}NO_3$. An alkaloid obtained from Belladonna Root.

Source.—Made by the following process: (1) Exhausting the root with Spirit; (2) precipitating the colouring matters with Lime, and filtering; neutralising excess of lime with Diluted Sulphuric Acid, and filtering; (3) distilling off alcohol, substituting Water, and thus precipitating (*a*) the resins and (*b*) the Atropine; (4) neutralising with Carbonate of Potassium; (5) removing the Atropine by solution in Chloroform, distilling off the latter, dissolving the residue in warm spirit, purifying with Charcoal, and crystallising.

Characters.—Colourless acicular crystals. *Solubility.*—Sparingly in water, more freely in alcohol and ether. Readily decomposed in solution. Its aqueous solution is alkaline, gives a citron-yellow precipitate with perchloride of gold, is bitter, and dilates the pupil. It can be chemically resolved into *tropine*, $C_8H_{15}NO$, and *tropic acid*, $C_9H_{10}O_3$; and reconstructed by the synthesis of these bodies. The intimate cause of the isomerism but non-identity of Atropine with the other alkaloids of the Atropaceæ has yet to be discovered. *Incompatibles.*—Caustic alkalies decompose it. Morphine, Physostigmine, and Strychnine are in various respects and degrees physiological antagonists. See *Opium*, page 224.

Preparation.

Unguentum Atropinæ.—1, dissolved in $3\frac{1}{2}$ of Spirit, in 55 of Benzoated Lard.

From Atropina is made:

Atropinæ Sulphas.—Sulphate of Atropine. *Source.*—Made by dissolving Atropine in Diluted Sulphuric Acid and Water, and evaporating. *Characters.*—Nearly colourless, crystalline or pulverulent. *Solubility.*—1 in 4 of water; solution neutral. *Dose*, $\frac{1}{120}$ to $\frac{1}{60}$ gr., but not given internally as such.

Preparations.

1. Liquor Atropinæ Sulphatis.—1 in 100 with Camphor Water. *Dose*, 1 to 4 min. by the mouth; or 1 to 5 min of a mixture of equal parts of the Liquor and Distilled Water hypodermically.
2. Lamellæ Atropinæ.—Discs of Gelatine, with some Glycerine, each weighing about $\frac{1}{50}$ gr., and containing $\frac{1}{5000}$ gr. of Sulphate of Atropine.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Belladonna and Atropine, as such or in aqueous suspension or solution, are not absorbed by the unbroken skin; but alcohol, chloroform, camphor, and glycerine, with which they are generally combined, readily convey the Atropine through the epidermis. Exposed mucous membranes and inflamed areas of skin still more readily absorb Atropine.

Belladonna depresses the sensory nerve endings, thus acting as a **local anæsthetic and anodyne**; the blood-vessels are first somewhat contracted, and then relaxed; and the motor-nerve filaments to underlying muscles are reduced in activity. Any other special nerve endings, with which the Atropine may come in contact are similarly depressed, *e.g.* the nerves of the sudoriparous and mammary glands.

Belladonna is used locally in Liniment, Plaster, or Ointment, and Atropine more rarely in Ointment, to relieve the pain and spasm of muscular rheumatism, and of neuralgia (less useful); as an anodyne and antiphlogistic in acute gout, boils, erysipelas, and other superficial inflammations, in all of which Glycerine of Belladonna (equal parts of the Extract and Glycerine), freely smeared on, is of great service; in pruritus and other skin diseases to relieve itching; and as an anti-galactagogue.

Internally.—The action of Belladonna on the mouth is not a local but a specific one, to be presently described. In the stomach it produces a slightly anodyne effect, and has been used to relieve some forms of gastralgia and sickness. Its action on the bowels is also specific, as will be seen.

2. ACTION IN THE BLOOD.

Atropine very rapidly enters the blood as such, and leaves it for the tissues. It does not alter the corpuscles.

3. SPECIFIC ACTION.

Atropine reaches the organs with remarkable rapidity, and sets up a train of characteristic phenomena. After moderate doses of an active preparation of Belladonna, patients almost invariably complain of dryness in the throat, with difficulty of swallowing; the pupils are dilated and vision confused; the bowels possibly relaxed; the pulse is reduced in frequency; the conjunctivæ and face are flushed; the balance and gait may be uncertain. Larger doses aggravate these phenomena, but the pulse now becomes frequent instead of the reverse; restlessness or even convulsions may occur; and the patient becomes delirious. These symptoms occasionally follow the incautious application of Belladonna to wounds or erupted areas of skin. Physiological analysis of these phenomena yields the following results:

Convolutions.—The **delirium** caused by Belladonna is rarely seen after medicinal doses. It is followed by dulness, somnolence, and insensibility, all evidences of cerebral depression.

Spinal cord.—Belladonna acts by no means powerfully on the cord, beyond slightly increasing and afterwards diminishing its reflex irritability.

Medulla.—The three great vital centres are markedly affected. The **respiratory centre is powerfully stimulated** by Belladonna, so that the movements of the chest become more frequent and more deep. This effect is independent of the blood pressure. Poisonous doses paralyse the same centre. The **cardiac centre is for a time stimulated** and the heart slowed. This is but a small part of the effect on the heart, as will be immediately seen. The **vaso-motor centre is first stimulated and then depressed** by Belladonna: that is, the systemic arteries are contracted and the blood pressure is raised for a time; afterwards the vessels are relaxed, and the pressure is lowered, causing the flushing of the skin.

The irritability of the *motor nerves* is diminished, but not lost, except after large doses. The *voluntary muscles* remain unaffected. The *sensory nerves*, which, as we have seen, are locally depressed, are also depressed specifically. Thus pain is prevented or relieved.

Special efferent nerve terminations.—A markedly depressing action is exerted by Belladonna upon the terminations of certain special motor or secretory nerves in connection with the viscera, or upon the "terminal apparatus" between these fibrils and the active protoplasm.

a. **The endings of the third nerve are paralysed in the sphincter of the pupil and in the ciliary muscle,** giving rise to the **dilatation of the pupil and the disturbance of accommodation.** The effect on the pupil is purely local in its cause; the muscle itself is also unaffected; possibly the sympathetic is somewhat stimulated. The amount of confusion of vision produced by the paralysis of accommodation will depend on the normal refraction of the patient's eye, long-sighted persons suffering most. The intra-ocular pressure is not diminished, as is often stated; it is increased by large doses.

b. **The terminations of the chorda tympani in the submaxillary gland are paralysed** by Atropine, the results being an arrest of saliva and the dryness of the mouth and throat already mentioned. The sympathetic remains unaffected, so that the vessels in the gland dilate as usual under stimulation, and the "sympathetic secretion" can be obtained as before. Probably the mucous glands of the mouth are also paralysed.

c. **The ends of the sudoriparous nerves in the sweat glands are depressed** by Atropine, which is the most powerful of all anhidrotics. Therewith the skin is flushed, as we saw; overspread sometimes by a scarlatinoid redness or rash. The temperature rises at first, but afterwards falls.

d. **The lacteal nerve terminations are paralysed,** and the secretion of milk (if present) arrested.

e. **The ends of the vagus (inhibitory apparatus) in the heart** may be **briefly stimulated** by Atropine, thus increasing its slowing action on the cardiac centre in the medulla, already seen; but they **are quickly paralysed,** the pulse rising in frequency to twice its previous rate after full doses; and this frequency cannot be reduced by faradising the vagus. Therewith *the force of the systole is not reduced after moderate doses.* Very large (poisonous) doses depress the ganglia, and finally even the muscle; and death occurs through cardiac failure, with the ventricle in diastole. The depressor and the accelerator filaments are not affected.

It will be convenient to complete here the account of the action of Belladonna on the circulation. The vaso-motor stimulation noted under the medulla coincides with the cardiac acceleration, and thus the blood pressure is decidedly raised, the heart emptying itself more frequently into tense vessels. Large doses, however, depress the vaso-motor centre; the peripheral vessels are also directly relaxed; the **pressure falls;** and if this be extreme, it coincides with the paralysis of the cardiac ganglia and muscle, and contributes to the final arrest of the circulation.

f. **The terminations of the vagus in the bronchial walls are paralysed** by Atropine, the tension of the muscular coat of the bronchi is diminished, and the air current is thus facilitated. **The afferent branches of the vagus in the same parts are also paralysed,** thus diminishing sensibility and reflex action, that is, dyspnœa and cough. These effects are in addition to the stimulation of the respiratory centre already noticed.

g. **The inhibitory branches of the splanchnics in the intestinal walls are depressed** by Atropine, which thus **increases** the **peristaltic movements** and causes relaxation of the bowels. It is doubtful whether the ganglia and plexuses, and the muscular coat, are also affected. The vaso-motor and sensory fibres of the splanchnics, however, resist Atropine.

h. Atropine appears to affect the terminations of the nerves of the *urethra*, *bladder*, and *vesiculæ seminales;* but this part of its action is still obscure. Frequent desire and inability to pass water is a symptom of over-doses.

Metabolism and temperature.—Nutritive activity is increased by Belladonna, obviously through the increased circulation and respiration; and most of the solid excretions are increased, as will be seen under the urine. The temperature is correspondingly raised; but it sinks with the failure of the circulation after large doses.

4. SPECIFIC USES.

From its sedative effect on the *convolutions*, Belladonna in full doses has been given in the low delirium of fevers, mania and alcoholism, especially if Opium fail. Neither for this purpose nor as a hypnotic can it be said to be in general use. It has also been recommended in such neuroses as epilepsy, chorea, and megrim; and in some cases relieves the symptoms of these, without effecting a cure.

Belladonna has been given with apparent success in many forms of *cord* disease, including spasmodic paralysis.

Liquor Atropinæ Sulphatis is extensively instilled into the *eye* as a mydriatic or pupil dilator, for ophthalmoscopic examination, and to prevent or break down adhesions in iritis; also to paralyse accommodation before determining refraction. The routine employment of Atropine in all kinds of eye disease is, however, to be deprecated, as it may sometimes precipitate glaucoma. See *Physostigma*, page 258.

Atropine occasionally relieves the *salivation* of Mercury, of pregnancy, and of cerebral disease, but is necessarily uncertain, as the pathology of such cases is often obscure.

Belladonna and Atropine are greatly used as *anhidrotics*, to check the sweats of phthisis and other hectic conditions. The Extract is generally used in pill at bedtime, or the Solution of Sulphate of Atropine when the case can be watched.

Applied in the form of Plaster, Liniment, or Ointment of Belladonna, or as a lotion of Atropine, this drug is constantly employed as an *anti-galactagogue*, to "dispel the milk" at any period after delivery. It may also arrest mammary abscess.

Belladonna is a valuable remedy in some cases of disease of the *heart and vessels*, where the indication is to empty the left ventricle quickly and relax the vessels, without diminishing the cardiac force. Such cases cannot be further particularised here, but it may be said that Belladonna is frequently given, either alone or combined with Digitalis, thus securing certain advantages of both drugs, whilst otherwise they may antagonise each other. Belladonna is clinically believed to relieve cardiac pain and palpitation, and is always to be preferred to Opium for this purpose; probably this effect is chiefly an indirect one, referable to frequent emptying of the ventricles, lowering of the vascular tension, and prevention of distension of the heart. The Plasters, or the Extract mixed with Glycerine, applied to the præcordium, the Extract internally, and Atropine subcutaneously, are more trustworthy forms for this purpose than the Tincture. A combination of Morphine and Atropine subcutaneously is especially valuable in cardiac distress. See *Opium: Combinations of Morphine and Atropine*, page 224.

Belladonna is used in diseases of the *respiratory organs*, both for the prevention and for the relief of spasm of the bronchi (asthma), spasmodic cough of any kind, and especially pertussis. It is difficult to over-estimate the value of this drug as a sedativo to the respiratory nerves, as compared with Opium. The latter also relieves spasm and cough, but tends to paralyse the respiratory centre, and has generally to be avoided. Belladonna soothes the afferent and efferent nerves of the bronchi, but strengthens the respiratory centre, and may be given with great confidence.

Some forms of chronic *constipation* are relieved by Belladonna, which is here usually given as the Extract combined with Aloes. Acute obstruction of the bowels may yield to Atropine, with or without Morphine. Fissure of the anus and spasm of the sphincter are benefited by its local use as a suppository.

Belladonna is useful in diseases of the *genito-urinary* organs, such as chordee, spermatorrhœa, some cases of retention of urine, the nocturnal incontinence of children, and all forms of painful spasm of the bladder, as in calculus, cystitis, and prostatitis. It is best given as suppository, or applied to the perinæum.

Belladonna or Atropine may be used in *poisoning by opium* (*see* page 224), and by calabar bean (*see* page 259.) Atropine is given in combination with Morphine to prevent certain unpleasant effects of the latter (*see* page 224.)

5. REMOTE LOCAL ACTION AND USES.

Atropine is excreted unchanged in the urine, almost immediately on its administration: in 10 to 20 hours the last traces have left the body. It increases the urea, phosphates, sulphates, and water, but not the chlorides of the urine; that is, is **diuretic.** It cannot be said to be much used for this purpose. In flowing over the ureters, bladder, and urethra, it may again relieve local pain and spasm, as indicated in the last section.

Stramonii Semina.—STRAMONIUM SEEDS. The dried ripe seeds of Datura Stramonium. Cultivated in Britain.

Characters.—Brownish-black, reniform, flat, finely pitted, wrinkled, $\frac{1}{6}$ inch long; taste bitterish; odour, when bruised, disagreeable.

Stramonii Folia.—STRAMONIUM LEAVES. (*Not official.*) The dried leaves of Datura Stramonium. Collected from plants in flower, cultivated in Britain.

Characters.—Large, ovate, sinuous, deeply cut; of a heavy odour, which is strongest while they are drying; and of a mawkish faintly bitter nauseous taste.

Substances resembling Stramonium Leaves: Belladonna Leaves, less wrinkled; Hyoscyamus Leaves, hairy.

Composition.—Both Seeds and Leaves contain a crystalline alkaloid, *daturine*, combined with malic acid. Daturine, $C_{17}H_{23}NO_3$, is either identical with hyoscyamine, which is isomeric but not identical with atropine (see *Belladonna*); or it is a variable mixture of atropine and hyoscyamine. *Incompatibles:* Daturine, like atropine, is decomposed by caustic alkalies. Metallic salts, and mineral acids.

Preparations of Stramonii Semina.

1. **Extractum Stramonii.**—Spirituous, *after washing with Ether. Dose*, $\frac{1}{6}$ to $\frac{1}{2}$ gr.
2. **Tinctura Stramonii.**—1 in 8 of *Proof* Spirit. *Dose*, 10 to 20 min.

ACTION AND USES.

Daturine has **an action almost exactly similar to that of Atropine.** Two points of difference require to be noticed: (1) that the Extract of Stramonium is more powerful than the green Extract of Belladonna; and (2) that Stramonium is more depressant to the nerves of the bronchi. The use of Stramonium is almost confined to the treatment of spasmodic affections of the respiratory organs, such as bronchitis and asthma. The Extract in doses of $\frac{1}{6}$ gr. may be given to prevent or lessen attacks; the Leaves smoked as cigarettes during the paroxysm.

Hyoscyami Folia.—HENBANE LEAVES. The fresh leaves and flowers, with the branches to which they are attached, of Hyoscyamus niger; also the leaves separated from the branches, and flowering tops, carefully dried. Collected from *biennial* plants, growing wild or cultivated in Britain, when about two-thirds of the flowers are expanded.

Characters.—Leaves of various lengths, sometimes even 10 inches; stalked or not; alternate; exstipulate; ovate-oblong, acute; undulated, irregularly toothed, sinuated, or pinnatifid; pale green and glandular-hairy, particularly beneath. Branches subcylindrical, glandular-hairy. The fresh herb has a strong heavy odour; a bitter, slightly acrid taste. The juice dropped into the eye dilates the pupil. *Substances resembling Hyoscyamus: See* Belladonna and Stramonium.

Composition.—The active principles are (1) *hyoscyamine*, $C_{17}H_{23}NO_3$, a crystalline alkaloid, but isomeric not identical with atropine; and (2) *hyoscine*, a syrupy alkaloid, also isomeric with atropine, and forming salts such as the hydrobromate and hydriodide. (See *Stramonii Folia* and *Belladonnæ Folia.*)

Incompatibles: Vegetable acids, Nitrate of Silver, Acetate of Lead, Liquor Potassæ and Liquor Sodæ.

Preparations.

1. **Extractum Hyoscyami.**—A *green* extract from the *fresh* plant. 20 in 1. *Dose*, 5 to 10 gr.

   From the Extract is prepared:

   PILULA COLOCYNTHIDIS ET HYOSCYAMI.—1 in 3. *See* page 278.

2. **Succus Hyoscyami.**—3 of *fresh* juice to 1 of Spirit. *Dose*, ½ to 1 fl.dr.
3. **Tinctura Hyoscyami.**—1, *dried*, in 8 of *Proof* Spirit. *Dose*, ½ to 1 fl.dr.

ACTION AND USES.

These **closely agree with the action and uses of Belladonna and Stramonium.** The special points to be noted in connection with Hyoscyamus are as follows: (1) The pharmaceutical preparations of the plant are decidedly weaker in their action, and must be given in larger doses. (2) The secondary or calmative effect of the atropaceous plants on the convolutions is more rapid and pronounced with Hyoscyamus, which is used in maniacal excitement. This result appears to be due to the hyoscine, which is a powerful cerebral sedative, controlling restlessness and inducing several hours' deep sleep. Hyoscine is best given as the hydriodide hypodermically, in doses of $\frac{1}{100}$ to $\frac{1}{50}$ gr. or more. It is doubtful how far hyoscyamine possesses this action, and in certain other respects the two alkaloids seem opposed to each other. (3) The laxative and carminative effects on the bowel are decided; and Hyoscyamus is often combined with purgative pills. (4) The remote local action on the urinary organs is more marked, and the Tincture is in general use to relieve irritability of the bladder.

Duboisine. (*Not official.*)—An alkaloid derived from an Australian plant, Duboisia myoporoides, and possibly identical with Hyoscyamine.

Sulphate of Duboisine, in golden-yellow scales, is more powerful than the Atropine salt, and may be used as a mydriatic, in the form of a solution, 1 gr. to the ounce. Stronger solutions are apt to produce general toxic effects.

Homatropine. (*Not official.*)—A derivative of Atropine. $C_{16}H_{21}NO_3$. Colourless prisms.

Its action is similar to that of Atropine, but weaker. It is used only in ophthalmic practice, its advantage being that whilst it acts as promptly though not so energetically as Atropine, its effects subside in about one-fourth the time.

Tabaci Folia.—LEAF TOBACCO. The dried leaves of Nicotiana Tabacum. From America.

Characters.—Large, sometimes over 20 inches long; ovate, acute; entire; brown; brittle; glandular-hairy; odour characteristic; taste nauseous-bitter, acrid.

Composition.—Tobacco contains 2 to 8 per cent. of a most powerful alkaloid, *nicotine*, and a concrete volatile oil, *nicotianin*, as well as alkaline salts and other less important substances. *Nicotine*, $(C_5H_7)_2N_2$, is a colourless, oily-looking, volatile fluid, with an irritating odour of Tobacco, and an acrid taste. It gives precipitates with perchloride of platinum and tincture of galls.

Tobacco smoke contains the very smallest trace only of nicotine, or none, but a number of volatile bodies, chiefly *pyridine* compounds, such as *pyridine*, C_5H_5N; *picoline*, C_6H_7N; *lutidine*, C_7H_9N: *collidine*, $C_8H_{11}N$, which have somewhat the same action as nicotine, but less severe. HCN and H_2S, other simpler gases, creasote, etc., also occur in tobacco smoke.

Pyridine is a colourless liquid with a powerful odour.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Tobacco, taken by the mouth, is a **gastro-intestinal irritant**, causing salivation, nausea, vomiting, severe colic, and repeated evacuations. The same effects may follow Tobacco-smoking, and the application of the leaf to the unbroken skin, or of snuff to the nose. Tobacco-smoking and snuffing may thus cause catarrh of the throat and stomach, and promote the movement of the bowels, facts of therapeutical interest. Tobacco is never given by the mouth. Snuff is an errhine.

Injected into the rectum, an enema of tobacco (20 gr. infused in 8 fl.oz. of boiling water) rapidly produces peristalsis, with expulsion of gas and fæces, and the specific effects to be described. It has been used in ileus and constipation.

2. ACTION IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTION AND USES.

Nicotine very rapidly enters the blood from all surfaces, but does not directly affect the corpuscles. All the organs are quickly reached. It acts chiefly upon the **nervous structures**, which it **first stimulates**, if given in very minute doses; but **afterwards depresses** in an extreme degree, causing **intense and universal debility**, which, with the local irritation of the alimentary canal, constitute a condition of collapse. On analysis it is found that Tobacco causes pleasing cerebral excitement, decided stimulation of the motor centres in the cord, with a feeling, and true increase, of muscular strength (ending in convulsions and paralysis, in poisonous doses); excitation, followed by paralysis, of the peripheral nerves, both sensory and motor; but no direct effect on the muscles. Respiration is first excited, then disturbed, and finally arrested, death by Tobacco being due to arrest of the respiratory centre. The action of Tobacco on the heart is not directly the cause of death: the heart is first slowed, then accelerated, and finally weakened with slowing, but it beats after respiratory death. The blood pressure falls, rises, and falls again, with the cardiac action, and from a direct central and peripheral effect on the vaso-motor apparatus. The temperature falls.

Tobacco was formerly employed in enema to produce general muscular debility and relaxation, for the reduction of hernia; but Chloroform has entirely displaced it. Its depressant effects suggest its use as an antispasmodic in whooping cough, asthma, hiccup, tetanus, and strychnine poisoning, rigidity of the cervix uteri, etc.; but such a powerful drug is very seldom employed.

Nicotine is excreted unchanged in the urine, saliva, and fæces. As a diuretic, Tobacco was formerly given in dropsy, but this use of the drug has also been abandoned.

Pyridine has lately been introduced as an antispasmodic in asthma. A fluid drachm is allowed to evaporate from a plate in a small room in which the patient sits for about half an hour three times a day.

SCROPHULARIACEÆ.

Digitalis Folia. — FOXGLOVE LEAVES. The leaves of Digitalis purpurea, the Purple Foxglove. Collected from wild British plants of the second year's growth when about two-thirds of the flowers are expanded, and carefully dried.

Characters.—From 4 to 12 or more inches long, sometimes as much as 5 or 6 inches broad, with a winged petiole; ovate, subacute, crenate; somewhat rugose; hairy, dull-green above; densely pubescent, paler beneath. Odour faint, agreeable, tea-like; taste very bitter, unpleasant. *Substance resembling Digitalis Leaves :* Matico; more deeply reticulated.

Composition.—The active principle of Digitalis, known as *digitalinum*, or *digitalin*, occurs in two forms: (*a*) *Homolle and Quévenne's digitalin*, a yellowish-white, amorphous or scaly, intensely bitter substance; and (*b*) *Nativelle's digitalin*, in crystalline prisms, also very bitter. It is now known to be a compound of four glucosides, namely, (1) *Digitalin* proper, $C_5H_8O_2$, insoluble in water, forming the bulk of Homolle's digitalin; (2) *Digitaleïn*, very soluble in water; (3) *Digitoxine*, $C_{31}H_{33}O_7$, insoluble in water, and the chief constituent of Nativelle's digitalin; and (4) *Digitonin*, $C_{31}H_{52}O_{17}$, probably the same as saponin, the active principle of Senega.

Incompatibles.—Persalts of iron, which give a slightly inky colour with Digitalis (tannates); acetate of lead; preparations of cinchona. *Dose of the powdered leaf*, ½ to 2 gr.

Preparations.

1. **Infusum Digitalis.**—1 in 156. *Dose*, 1 to 4 fl.dr.
2. **Tinctura Digitalis.**—1 in 8 of *Proof* Spirit. *Dose*, 5 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Digitalis has a slightly irritant action; it is probably not absorbed by the unbroken skin.

Internally, in full doses, it deranges the stomach and bowels; dyspepsia, vomiting, and occasionally diarrhœa following its continued use, effects which are partly local, partly specific, and to be avoided or checked in practice.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

The active principles of Digitalis enter the blood freely. Thence they reach the tissues more quickly than they leave them; and doses, however small, tend to accumulate in the body if closely repeated. **The action of Digitalis is mainly confined to the circulatory organs,** the other parts being chiefly affected secondarily. Both the heart and vessels are influenced by the drug, the action of which occupies *four stages*, the first stage being shorter, the other stages more marked, as the dose is increased.

In the *first stage* the heart falls in frequency (say to sixty per minute), from stimulation of the vagus in the heart and medulla; and beats with increased force, from stimulation of the intrinsic ganglia. Therewith the arterial pressure rises, from the increased cardiac force, and from excitation both of the vaso-motor centre and vaso-motor nerves. The result of all this is that the ventricles are well filled (diminished frequency, *i.e.* lengthened diastole); the ventricles are thoroughly emptied (increased force); the arteries are thus well-filled; and they are kept filled (vaso-motor action). The condition is that of a perfect circulation, which **empties the veins and fills the arteries.**

In the *second stage*, the state of the heart remains unchanged, but the vaso-motor apparatus of the renal arteries is rather suddenly depressed; these vessels are relaxed, and the force of the circulation is thus thrown upon them, that is, on the glomeruli. The result is **increase in the excretion of urinary water.**

In the *third stage*, the heart rises in frequency from depression of the vagus, and probably some irritation of the sympathetic (accelerator) fibres; and it loses force from commencing exhaustion of the intrinsic ganglia and muscle. At the same time the arterial pressure falls, from the weakening of the heart, and the depression of the vaso-motor apparatus, which spreads from the kidney, where it commenced, to the other peripheral arterioles. Thus the **circulation begins to fail.**

In the *fourth stage*, the action of the heart becomes irregular, infrequent, and weak, from failure of the ganglia and myocardium; and it is finally arrested in diastole. Therewith the blood pressure gradually sinks to zero, from loss of cardiac force and complete paralysis of the vessel walls. **Death occurs by general circulatory failure.**

Respiration fails at last, but only through the circulation. The *voluntary muscles* are paralysed through failure of their blood supply. The *uterus* is said to be stimulated by moderate doses. The *body temperature* is briefly raised through increased vigour of the circulation; it is then lowered by the increased blood-flow in the skin; and falls still more in the last stages, in an irregular uncertain way, from causes still obscure. Digitalis is thus a **refrigerant**. The *central nervous system* is only secondarily affected through the blood supply. Headache, giddiness, disturbance of sight and vision are frequently induced by medicinal doses of Digitalis; with a sense of faintness, depression, nausea, or actual sickness. *Metabolism* is variously influenced by Digitalis, according to the length of the different stages and the rapidity of their development. When the pressure and temperature are high, the urea and uric acid may be increased, and certain salts diminished in amount.

The effect of Digitalis on the *urine* is equally uncertain in the healthy individual; the period at which the renal vessels begin to be relaxed, the duration of the second stage, and the relation of the action of the drug on the heart to its action on the vessels, being all variable. As a rule, the urine is not increased in bulk in health, but remarkably increased in some cases of dropsy to be presently referred to.

4. SPECIFIC USES.

Digitalis is one of the most valuable of medicinal remedies, and is employed in the following conditions:

Digitalis is indicated in **disease of the heart**, when the nervo-muscular structures of the cardiac walls fail, so that the circulatory force falls, the cavities are incompletely emptied, the arteries are insufficiently filled, the veins imperfectly drained, and the blood accumulates behind the seat of disease. Such a condition is characterised by cardiac distress and pain; a small, weak, and often irregular pulse; distension of the veins, hæmorrhage, dropsy, and visceral disorder; and often by congestion of the lungs and great dyspnœa. It occurs under a variety of circumstances which demand separate consideration:

The disturbances of the circulation produced by disease of the *valves* of the heart are removed by a natural process of compensation, consisting of hypertrophy of the muscular walls, with or without dilatation of the cavities. If this compensation do not occur, or fail after having been established, and the circulation be disordered as described, Digitalis may give relief, by increasing the force of the cardiac wall; by lengthening diastole, so that the venous flow and the ventricular rest are both prolonged; and by sustaining the pressure on the arteries, thus driving the blood in a steady stream into the veins. All the symptoms will be thus removed, including dropsy, the fluid being absorbed by the increased venous flow and excreted by the kidneys as a profuse diuresis. Mitral disease, tricuspid incompetence, and aortic obstruction are the forms of valvular disease in which imperfect or failing hypertrophy is relieved by Digitalis. In aortic incompetence the drug is contraindicated, as prolonging diastole, and thus permitting greater reflux; but this practice is not to be carried too far, and Digitalis may be given if the ventricle fail. In mild cases, when little more than a tonic effect on the heart is desired, the Tincture is prescribed. When dropsy is present, and the patient confined to bed, the Infusion or the powdered leaf should be given, and the effect carefully watched. Without nourishing, digestible, and digested food Digitalis can only exhaust the heart, and attention must therefore be paid to the stomach, liver, and bowels. Iron, and occasionally Quinine, may be combined with advantage, but only after the excretory and digestive functions have been restored. Let it be carefully observed that Digitalis is not to be given in a routine fashion for valvular disease, but *with reference to the state of the muscular wall associated with the lesion.*

Digitalis is of great service in failure of the heart from *primary* disease of the walls, as in chronic myocarditis; in the granular degeneration of acute myocarditis, pericarditis, and endocarditis, occurring in scarlet fever and acute rheumatism; and in acute alcoholism. In fatty degeneration it may have to be withheld, lest irregular contraction and rupture occur. Digitalis restores the vigour of the heart in failing hypertrophy of *chronic Bright's disease*, when it is breaking down against excessive peripheral resistance; until the heart begins to fail, the drug is contraindicated, but when dilatation sets in, it must be given. In *functional* or *nervous* palpitation, pain, or irregularity, with debility and dyspepsia, Digitalis is often valuable, as also in reflex cases with gastric disorder, where small doses control the vagus; but it must be given intermittently, the dyspeptic effect of the drug also being remembered. Digitalis is harmful in pure *hypertrophy*. In disease of the *right ventricle* from chronic lung disease it is occasionally useful, but fails entirely in some cases. In *exophthalmic goître* it is invaluable combined with Quinine and Iron. In *cardiac dropsy* Digitalis is a thoroughly rational and highly successful remedy. In *renal dropsy* it is of great service when this is acute, complicating scarlet fever, or when due to failure of an hypertrophied heart. In dropsy from chronic tubular nephritis (large white kidney) it is rarely of use, as it has no influence on the renal cells.

Digitalis is used in hæmorrhage, but therapeutics is notoriously uncertain here. It will relieve hæmoptysis due to mitral disease, or to the congestion of incipient phthisis with a languid circulation. For menorrhagia it may be useful by stimulating the uterine wall, or in the subjects of heart disease.

Digitalis is but little used by English physicians as an antipyretic in fever, as it is slow, uncertain, dangerous, and unnecessary. In secondary bronchial catarrh and acute pneumonia it acts chiefly as a cardiac stimulant. Combined with Quinine it is exhibited in phthisis, but is apt to derange digestion. Empirically, in doses of several drachms, the Tincture has been found useful in *delirium tremens*, but is unquestionably dangerous. Moderate doses are invaluable in the same disease, or in subacute or chronic cases of alcoholism, to stimulate the heart, relieve low sinking feelings, and rouse the appetite.

5. REMOTE LOCAL ACTION.

Traces of some of the active principles of Digitalis have been detected in the urine. The action of the drug upon the urine, let it be carefully noted, is not due to any direct influence on the cells of the kidney; but chiefly on the heart and vessels generally, partly on the renal arteries.

6. ACTIONS OF THE CONSTITUENTS OF DIGITALIS.

Digitalein seems to possess the properties of a mixture of digitalin and digitonin. Digitoxin is by far (7 times) the most powerful, a local irritant, and a muscular depressant; and therefore, and because insoluble, unfit for use. None of the constituents are so suitable as Digitalis Leaf itself.

LABIATÆ.

Oleum Rosmarini.—OIL OF ROSEMARY. The oil distilled from the flowering tops of Rosmarinus officinalis.

Characters.—Colourless or pale yellow; odour characteristic; taste warm, aromatic.

Composition.—Oil of Rosemary consists of a terpene, $C_{10}H_{16}$, and a stearoptene, $C_{10}H_{16}O$. *Dose*, 1 to 4 min.

Preparation.

Spiritus Rosmarini.—1 to 49 of Spirit. *Dose*, 10 to 30 min.

Oil of Rosemary is also contained in Linimentum Saponis and Tinctura Lavandulæ Composita.

ACTION AND USES.

Rosemary resembles the other **aromatic** oils in its action and uses. It is a favourite component of stimulating lotions.

Oleum Lavandulæ.—OIL OF LAVENDER. The oil distilled in Britain from the flowers of Lavandula vera.

Characters.—Nearly colourless or pale yellow, with the very fragrant odour of Lavender, and a hot bitter aromatic taste. *Impurities.*—Oils of spike and turpentine.

Composition.—Oil of Lavender is a mixture of a terpene, $C_{10}H_{16}$, and a stearoptene, $C_{10}H_{16}O$. *Dose*, 1 to 4 min.

Preparations.

1. **Spiritus Lavandulæ.**—1 to 49 of Spirit. *Dose*, ½ to 1 fl.dr.
2. **Tinctura Lavandulæ Composita.**—Oil of Lavender, 90 min.; Oil of Rosemary, 10 min.; Cinnamon, 150 gr.; Nutmeg, 150 gr.; Red Sandal Wood, 300 gr.; Rectified Spirit, 40 fl.oz. *Dose*, ½ to 2 fl.dr.

Tinctura Lavandulæ Composita is contained in Liquor Arsenicalis; *Oleum Lavandulæ is also an ingredient of* Linimentum Camphoræ Compositum.

ACTION AND USES.

Lavender possesses the action of **aromatic** volatile oils in general, and is used in the same way. The Tincture is a favourite colouring material for mixtures and lotions.

Oleum Menthæ Piperitæ.—OIL OF PEPPERMINT. The oil distilled in Britain from fresh flowering Peppermint, Mentha piperita.

Characters.—Colourless, pale yellow or greenish-yellow, becoming thicker and reddish by age; with characteristic odour; taste penetrating and aromatic, succeeded by a sense of coldness in the mouth. *Dose*, 1 to 4 min.

Oleum Menthæ Viridis.—OIL OF SPEARMINT. The oil distilled in Britain from fresh flowering Spearmint, Mentha viridis.

Characters.—Colourless, pale yellow or greenish-yellow, becoming reddish by age; with characteristic odour and taste.

Composition.—Peppermint Oil consists of a terpene, *menthene*, $C_{10}H_{18}$, and the official stearoptene, *menthol* or *peppermint-camphor*, $C_{10}H_{20}O$. Oil of Spearmint has a somewhat similar composition, *carvol*, $C_{10}H_{14}O$, replacing menthol. *Dose*, 1 to 4 min.

Preparations.

A. *Of Oil of Peppermint:*

1. **Aqua Menthæ Piperitæ.**—1 in 853, by distillation. *Dose,* 1 to 2 fl.oz. *Aqua Menthæ Piperitæ is contained in* Mistura Ferri Aromatica.
2. **Essentia Menthæ Piperitæ.**—1 to 4 of Spirit. *Dose,* 10 to 20 min.
3. **Spiritus Menthæ Piperitæ.**—1 to 49 of Spirit. *Dose,* 30 to 60 min.

Oil of Peppermint is also contained in Pilula Rhei Composita and Tinctura Chloroformi et Morphinæ.

B. *Of Oil of Spearmint:*

Aqua Menthæ Viridis.—1 in 853, by distillation. *Dose,* 1 to 2 fl.oz.

Menthol.—MENTHOL. $C_{10}H_{20}O$. A stearoptene obtained by cooling the oil distilled from the fresh herb of Mentha arvensis (vars. piperascens et glabrata), and of Mentha piperita.

Characters.—Colourless needles, usually moist from adhering oil; or fused crystalline masses. Has the odour and flavour of peppermint, producing warmth on the tongue, or, if air is inhaled, a sense of coolness. *Solubility.*—Sparingly in water, readily in spirit; the solutions neutral. Entirely dissipated by the heat of a water-bath. Boiled with H_2SO_4 and water it becomes indigo-blue, the acid brown. *Dose,* $\frac{1}{2}$ to 2 gr.

ACTION AND USES.

Peppermint possesses in the main the action of other **aromatic** oils (see *Caryophyllum,* page 272), and is used accordingly. It is a favourite flavouring agent, with powerful carminative effects. In two important respects, however, Peppermint Oil is peculiar: (1) *locally,* instead of dilatation it causes at first acute contraction of the vessels, leading to a sense of coldness; (2) it appears to diminish instead of increasing the white corpuscles in the blood, by checking the activity of the intestinal absorbents.

Menthol has lately been used locally to relieve the pain of rheumatism, neuralgia, and toothache, as possessing in a marked degree the **local anæsthetic,** vascular stimulant, and disinfectant action of volatile oils, described under *Oleum Terebinthinæ* (page 377). It is of no real value as an antiseptic dressing.

Thymol.—THYMOL. $C_{10}H_{13}HO$. A stearoptene obtained from the volatile oils of Thymus vulgaris, Monarda punctata, and Carum Ajowan.

Source.—Made by saponifying the oils with Caustic Soda, and treating the soap with Hydrochloric Acid; or from a distilled fraction of the oil by exposure at a low temperature. Purified by recrystallisation from alcohol.

Characters.—Large oblique prisms, having the odour of thyme and a pungent aromatic flavour. *Solubility.*—1 in 800 of cold water; freely in alcohol, ether, and solution of alkalies. Volatilised completely by the heat of a water-bath. A solution in glacial acetic acid, warmed with H_2SO_4, becomes reddish-violet. *Dose,* ½ to 2 gr.

Non-official Preparations.

(1) THYMOL SOLUTION.—1 in 1000.
(2) THYMOL GAUZE.—Contains 1 per cent. of Thymol.
(3) THYMOL OINTMENTS.—From 5 to 30 gr. in 1 oz.

ACTION AND USES.

Externally, Thymol is **antiseptic, disinfectant, and deodorant,** 1 part in 109 killing developed bacteria. Although it is more active than Carbolic Acid, and has the further advantage of a pleasant odour and a less irritant effect on animal tissues, it has not come to be much used in the Listerian system. The solution may be employed as a lotion, injection, or spray; a spirituous and ethereal solution (1 in 15) as an application in ringworm; and the Ointments in various diseases of the skin.

Internally, the action of Thymol somewhat resembles that of Turpentine; but it has not proved of therapeutical value.

POLYGONACEÆ.

Rhei Radix.—RHUBARB ROOT. The root partly deprived of its bark, sliced, and dried, of Rheum palmatum; Rheum officinale; and probably other species. Collected and prepared in China and Thibet.

Characters.—Somewhat cylindrical, conical, or irregular pieces. Outer surface somewhat angular; covered with a bright yellowish-brown powder; and marked beneath the powder with reddish-brown lines in a yellowish-brown substance, with small star-like spots. The pieces are often bored with a hole which may contain the remains of the cord used to suspend them to dry. Hard, compact; fracture uneven, marbled, with sometimes a ring of star-like spots. Odour peculiar, somewhat aromatic; taste bitter, feebly astringent; gritty between the teeth.

Composition.—Rheum contains 3 to 4 per cent. of *cathartic acid*, the purgative constituent of Senna (*see* page 260). With this is combined *rheo-tannic acid*, possessing astringent properties. The yellow colouring matter is *chrysophan* (*see* page 259). *Emodin*, *phæoretin*, *starch*, *resins*, and *oxalate of lime* (35 per cent.) are less important constituents. *Impurities.*—English Rhubarb, known by taste, odour, and excess of starch. Turmeric, turned brown by boric acid. *Dose*, as a stomachic, 1 to 5 gr.; as a purgative, 10 to 20 gr.

Preparations.

1. **Extractum Rhei.**—Spirituous and aqueous. 100 in 39. *Dose*, 5 to 15 gr.
2. **Infusum Rhei.**—1 in 40. *Dose*, 1 to 2 fl.oz.
3. **Pilula Rhei Composita.**—Rhubarb, 6; Socotrine Aloes, 4½; Myrrh, 3; Hard Soap, 3; Oil of Peppermint, ⅓; Glycerine, 2; Treacle, 6. *Dose*, 5 to 10 gr.
4. **Pulvis Rhei Compositus.**—"Gregory's Powder." Rhubarb, 2; Light (or Heavy) Magnesia, 6; Ginger, 1. *Dose*, 20 to 60 gr.
5. **Syrupus Rhei.**—Rhubarb, 2; Coriander, 2; Sugar, 24; Spirit, 8; Water, 24. *Dose*, 1 to 4 fl.dr.
6. **Tinctura Rhei.**—Rhubarb, 2; Cardamoms, ¼; Coriander, ¼; Saffron, ¼; Proof Spirit, 20. *Dose*, as a stomachic, 1 to 2 fl.dr.; as a purgative, ½ to 1 fl.oz.
7. **Vinum Rhei.**—Rhubarb, 11; Canella, 1; Sherry, 146. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action of Rhubarb is confined to the alimentary canal. In small doses (1 to 5 gr.), the bitter principle and rheo-tannic acid are chiefly active, as **bitter stomachics and intestinal astringents.** In larger doses (up to 40 gr.) the cathartic acid exerts its influence before the rheo-tannic acid; **stimulates the intestinal movements and liver,** as in Senna, with some griping; and causes **purgation,** producing in six to eight hours a liquid motion, of a yellow colour from the pigment of the Rhubarb and excess of bile. Thereafter, the effect of the tannic acid becomes evident, and the bowels are confined.

Rhubarb is used in small doses as a bitter stomachic, intestinal astringent, and tonic, to correct atonic indigestion with diarrhœa, as in dyspeptic and rickety infants and children. Larger doses are given as a purgative, in the form of the Compound Powder, combined sometimes with a mercurial, to sweep out the bowels and then set them at rest, in cases of summer diarrhœa, and *diarrhœa ab ingestis* of children. The Compound Pill is a familiar mild laxative for habitual use, suiting some persons but demanding constant repetition in the majority. The cholagogue action of Rhubarb adds to its value both in stomachic and purgative preparations. Its griping effect must be remembered, and the drug never given alone.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

The chrysophan, at least, is absorbed into the blood, passes through the tissues, and is thrown out in the secretions, which it stains yellow, including the urine.

MYRISTICACEÆ.

Myristica.—NUTMEG. The dried seed of Myristica fragrans, divested of its hard coat or shell. From the Malayan Archipelago.

Characters.—Ovoid; about an inch long; greyish-brown externally, with reticulated furrows; internally greyish-red with brownish-red veins, so that the transverse section is marbled. Odour strong, pleasantly aromatic; taste agreeably aromatic, warm, bitterish.

Composition.—Nutmeg and mace contain about 30 per cent. of the official *concrete oil,* 4 to 9 per cent. of the official *volatile oil,* starch, etc.

Nutmeg is contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Spiritus Armoraciæ Compositus, and Tinctura Lavandulæ Composita.

From Myristica are made :

1. **Oleum Myristicæ Expressum.**—A concrete oil obtained from Nutmeg by expression and heat. Orange-coloured, mottled, of firm consistence, with the odour of Nutmeg. Is composed of glyceryl combined with *oleic, butyric,* and *myristic* ($HC_{14}H_{27}O_2$) *acids;* with a little volatile oil and resin.

Oleum Myristicæ Expressum is contained in Emplastrum Calefaciens and Emplastrum Picis.

2. **Oleum Myristicæ.**—The oil distilled in Britain from Nutmeg. Colourless, fragrant. Consists chiefly of a terpene, *myristicen*, $C_{10}H_{16}$, and *myristicol*, $C_{10}H_{16}O$. *Dose*, 1 to 4 min.

Preparation.

SPIRITUS MYRISTICÆ.—1 to 49 of Spirit. *Dose*, 30 to 60 min.
Spiritus Myristicæ is contained in Mistura Ferri Composita.
Oleum Myristicæ is contained in Pilula Aloes Socotrinæ and Spiritus Ammoniæ Aromaticus.

ACTION AND USES.

The Expressed Oil has locally the **mechanical and stimulant** actions of the fixed and volatile oils, and is used as an inunction or in plasters to relieve the pain and swelling of chronic rheumatism, etc. The Volatile Oil resembles its many allies, and is chiefly used for culinary purposes.

LAURACEÆ.

Cinnamomi Cortex.—CINNAMON BARK. The dried inner bark of shoots from the truncated stocks or stools of the cultivated Cinnamon tree, Cinnamomum zeylanicum. Imported from Ceylon, and distinguished in commerce as Ceylon Cinnamon.

Characters.—Closely rolled quills, each about $\frac{3}{8}$ of an inch in diameter, and containing smaller quills. It is thin, brittle, splintery, light yellowish-brown externally, with little scars or holes and faint shining wavy lines; darker brown within. Odour fragrant; taste warm, sweet, aromatic. *Impurity:* Cassia bark, rougher, thicker, less aromatic, starchy.

Composition.—Cinnamon Bark contains the official *volatile oil*, *tannic acid*, *sugar*, and *gum*. *Dose*, 10 to 20 gr.

Preparations.

1. **Aqua Cinnamomi.**—1 in 8, by distillation. *Dose*, 1 to 2 fl.oz.
2. **Pulvis Cinnamomi Compositus.**—Cinnamon, 1; Cardamoms, 1; Ginger, 1. *Dose*, 3 to 10 gr.
   Pulvis Cinnamomi Compositus is contained in Pilula Aloes et Ferri, and Pilula Cambogiæ Composita.
3. **Tinctura Cinnamomi.**—1 in 8. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

Cinnamon is also contained in Pulvis Catechu Compositus, Pulvis Cretæ Aromaticus, Pulvis Kino Compositus, Decoctum

Hæmatoxyli, Infusum Catechu, Tinctura Cardamomi Composita, Tinctura Lavandulæ Composita, and Vinum Opii.

From Cinnamomi Cortex is made:

Oleum Cinnamomi.—The oil distilled from Cinnamon. Yellowish when recent, becoming red; odour and taste of Cinnamon. Contains (or yields) cinnamic aldehyde, C_8H_7COH, and cinnamic acid, C_8H_7COOH, as well as benzoates. See *Styrax*, page 368, and *Balsamum Peruvianum*, page 255. *Dose*, 1 to 4 min.

Preparation.

SPIRITUS CINNAMOMI.—1 to 49 of Spirit. *Dose*, ½ to 1 fl.dr.

Spirit of Cinnamon is contained in Acidum Sulphuricum Aromaticum.

ACTION AND USES.

Cinnamon, besides possessing the same action, and being used for the same purposes, as other **aromatic** substances (see *Caryophyllum*, page 272), has moderately **astringent** properties in virtue of its tannic acid. It is therefore the favourite flavouring and carminative agent in the official astringent powders, tinctures, etc. These are chiefly used in diarrhœa.

Camphora.—CAMPHOR. $C_{10}H_{16}O$. A stearoptene obtained from the wood of Cinnamomum Camphora. Imported crude from Japan and China; purified by sublimation.

Characters and composition.—Solid, colourless, translucent crystalline masses, with many fissures; tough, but readily powdered if moistened with spirit, ether, or chloroform; odour powerful, penetrating; taste pungent, bitter, followed by a sensation of cold. It floats on water (sp. gr. ·990); burns readily with a bright smoky flame; volatilises at ordinary temperatures; sublimes entirely when heated. *Solubility:* very slightly in water; readily in spirit, ether, or chloroform. Forms a fluid compound with Carbolic Acid, Chloral Hydrate, Thymol, etc. Borneo Camphor, sometimes substituted for Japan Camphor, is obtained from Dryobalanops aromatica; has the formula $C_{10}H_{18}O$, *i.e.* bears the same relation to it as alcohol to aldehyde; and sinks in water. *Dose*, 1 to 5 gr.

Preparations.

1. **Aqua Camphoræ.**—About ½ gr. in 1 fl.oz., by maceration. *Dose*, 1 to 2 fl.oz.
2. **Linimentum Camphoræ.**—1 to 4 of Olive Oil.

3. **Linimentum Camphoræ Compositum.**—20; Strong Solution of Ammonia, 40; Spirit, 120; Oil of Lavender, 1.
4. **Spiritus Camphoræ.**—1 in 10 of Rectified Spirit. *Dose*, 10 to 30 min. (in milk or on sugar).
5. **Tinctura Camphoræ Composita.**—"Paregoric Elixir." Camphor, 30 gr.; Opium, 40 gr.; Benzoic Acid, 40 gr.; Oil of Anise, ½ dr.; *Proof* Spirit, 20 fl.oz. 1 fl.dr. contains ¼ gr. of Opium. *Dose*, 15 to 60 min.

Camphor is also contained in Linimenta Aconiti, Belladonnæ, Chloroformi, Hydrargyri, Opii, Saponis, Sinapis Compositum, Terebinthinæ, and Terebinthinæ Aceticum; and in Unguentum Hydrargyri Compositum.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Camphor closely resembles in its action the volatile oils, as described under *Oleum Terebinthinæ.* It is (1) weakly **antiseptic**; (2) **stimulating to the local circulation**; and (3) **sedative to the nerves after preliminary stimulation.** The uses of Camphor externally depend on these properties: the many liniments and ointments which contain it are intended to increase the nutrition of indurated or stiffened parts, to relieve pain, or to produce counter-irritation. The compounds with Carbolic Acid, Chloral, and Thymol, are anodynes.

Internally.—Camphor combined with Carbolic Acid forms an antiseptic and anæsthetic dressing for carious teeth. On the tongue it produces its peculiar taste, increase of the local circulation, salivation, and mucous flow. Reaching the stomach, it causes a sense of warmth; is a weak antiseptic; and again acts like Turpentine. Briefly, it is a **carminative**: its purely local action stimulating digestion and relieving flatulence, and its reflex effects being visible in increased action of the heart, fulness and force of the pulse, and cerebro-spinal excitation. Its carminative properties, whilst generally applicable, are specially valuable in hysterical vomiting.

The intestinal effects of Camphor are similar, and it is therefore useful in some forms of diarrhœa, in the first stage of cholera, and in meteorism.

2. ACTION ON THE BLOOD.

Camphor enters the blood freely from the unbroken skin and mucous surfaces, and is found in it unchanged. The leucocytes markedly increase in number, apparently from the stimulation of the abdominal circulation.

3. SPECIFIC ACTION AND USES.

In the organs and tissues a portion of the Camphor administered is found unchanged; the rest appears to combine with glucose. The nervous system is chiefly affected by this drug, which in doses above those usually ordered may so act on the cerebrum as to produce a kind of **intoxication**, with confusion of mind and speech, excited gait and gesture, and thereafter convulsions, probably originating partly also in the medulla. Moderate doses are said to produce an aphrodisiac, followed by an anaphrodisiac, effect. The heart is stimulated directly, as well as reflexly from the stomach as we have seen. Camphor has accordingly been used in nervous and cardiac prostration, especially in the acute specific fevers, such as typhoid and erysipelas; in poisoning by opium and other narcotics; in alcoholism, including delirium tremens; and in various nervous disorders, dependent probably on disturbance of the cerebral and spinal centres, such as insanity, hysteria, whooping cough, priapism, and spermatorrhœa. In large doses of particular preparations, and probably in certain subjects, Camphor instead of excitement produces rapid depression, chiefly referable to the heart: namely, failure of the pulse, pallor, coldness and moistness of the surface, impaired local sensibility, and unconsciousness. The respiration is much disturbed after full doses, in association with convulsions and coma. Camphor is a decided **diaphoretic** through its action on the sweat centres. Its action on metabolism is unknown, except that it lowers the body temperature, both in health and in pyrexia. Both these effects may contribute to the value of Camphor in fevers.

4. REMOTE LOCAL ACTION AND USES.

Camphor is excreted unchanged by the respiratory organs, on which it probably acts like Turpentine. It is a common ingredient of **expectorant** mixtures, especially as the Compound Tincture. The skin also throws out Camphor, which not only specifically increases, but gives its odour to the perspiration. This **refrigerant** action accounts for the popular use of the drug in common colds. The kidneys do not excrete Camphor as such, but as a complex product.

Sassafras Radix.—SASSAFRAS ROOT. The dried root reduced to chips or shavings of Sassafras officinale. From North America.

Characters.—Large branched pieces, covered with bark; more usually in chips or shavings. Bark rough, greyish-brown externally; internally smooth, glistening, rusty-brown; odour agreeable, aromatic; taste peculiar, aromatic, somewhat astringent. Wood soft, light; greyish-yellow or red, with a more feeble taste and odour than the bark.

Composition.—Sassafras contains a *volatile oil*, consisting chiefly of *sassafrol*, $C_{10}H_{10}O_2$, and a terpene; a *resin*; and a neutral crystalline body, *sassafrin.*

Sassafras is contained in Decoctum Sarsæ Compositum.

ACTION AND USES.

The physiological action of Sassafras is unknown. The drug is rarely used alone, but in the Compound Decoction of Sarsaparilla. It is supposed to increase the action of the skin and kidneys in syphilis, rheumatism, etc., and thus to be an **alterative.** See *Sarsæ Radix*, page 388.

Nectandræ Cortex.—BEBEERU BARK. The bark of Nectandra Rodiæi, the Greenheart Tree. Imported from British Guiana.

Characters.—Flattish heavy pieces, 1 to 2 feet long, 2 to 6 inches broad, ¼ inch or more thick. Externally greyish-brown; internally dark cinnamon-brown, with longitudinal striæ. Very hard, brittle, fracture coarse-grained. Inodorous; taste strong, bitter, astringent.

Composition.—The active principle of Bebeeru Bark is the official *beberine*, with *tannin.*

From Nectandræ Cortex is made:

Beberinæ Sulphas.—Sulphate of Beberine.

Source.—Made by (1) exhausting the powdered bark with Sulphuric Acid and Water, and concentrating the liquor; (2) precipitating the colouring matter with Lime, short of neutralisation; (3) filtering and precipitating impure Beberine by Solution of Ammonia; (4) washing and drying the precipitate, and dissolving it in Spirit, distilling off the latter, and dissolving the residue in Diluted Sulphuric Acid; (5) purifying, and evaporating to dryness on glass plates.

Characters.—Dark-brown, thin, translucent scales; yellow when in powder; with a strong bitter taste. Is probably a mixture of Sulphates of Beberine, $C_{36}H_{42}N_2O_6$, Nectandrine, $C_{40}H_{46}N_2O_8$, and other alkaloids. *Solubility:* 1 in 80 of water;

sparingly in spirit. Aqueous solution gives a yellowish-white precipitate with NaHO, soluble in ether. *Incompatibles.*—Alkalies and their carbonates, bromide and iodide of potassium, lime-water, tartaric acid and tartrates, astringent infusions and tinctures. *Dose*, 1 to 10 gr.

ACTION AND USES.

Beberu Bark is an **aromatic bitter, stomachic and tonic** in its effects, like Orange and Cascarilla; the alkaloid possesses the properties of a pure bitter. Like all other substances of this class, Beberine is antiseptic, and to a small extent **antipyretic and antiperiodic**; but these effects being insignificant, its use in fever and ague has now been abandoned.

ARISTOLOCHIÆ.

Serpentariæ Rhizoma. — SERPENTARY RHIZOME. The dried rhizome and rootlets of Aristolochia Serpentaria, or of Aristolochia reticulata. From North America.

Characters.—Rhizome twisted, about 1 inch long and $\frac{1}{8}$ of an inch in diameter; marked above by remains of former stems; giving off below a tuft of slender rootlets, 1 to 4 inches long; dull yellowish-brown. Odour aromatic, camphoraceous; taste bitter, aromatic, camphoraceous. The rhizome of *Aristolochia reticulata* is a little thicker; the rootlets longer, coarser, and less matted. *Substances resembling Serpentary:* Arnica, Valerian, Veratrum Viride (*q.v.*).

Composition.—Serpentary contains chiefly a *volatile oil* and a *resin*, with some *bitter* principle.

Preparations.

1. **Infusum Serpentariæ.**—1 in 40. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Serpentariæ.**—1 in 8 of *Proof* Spirit. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

Serpentary is contained in Tinctura Cinchonæ Composita.

ACTION AND USES.

Serpentary possesses **local and general stimulant and tonic** properties, closely resembling those of Valerian and Cascarilla. It is occasionally used in nervous, despondent, or excitable conditions, as well as in low fevers and febrile states.

Coto Bark.—CORTEX VERUS. **Paracoto Bark.**—CORTEX PARA. (*Not official.*) The barks of two allied trees, from Bolivia.

Characters.—Coto Bark somewhat resembles Cinchona Bark, with an aromatic resinous odour, and a pungent taste.

Composition.—Coto verus contains *cotoïn*, $C_{22}H_{18}O_6$, yellowish, amorphous or finely crystalline, with a balsamic odour and a bitter taste; nearly insoluble in water, soluble in spirit. Para bark contains *paracotoïn*, $C_{19}H_{12}O_6$, in minute pale crystals; insoluble in water. *Dose*, of cotoïn, ½ to 2 gr.; of paracotoïn, 1½ to 3 gr.

ACTION AND USES.

The only physiological effect of Coto is as an **intestinal astringent.** It is useful in persistent subacute or chronic diarrhœa in phthisical and delicate subjects.

SANTALACEÆ.

Oleum Santali.—OIL OF SANDAL WOOD. The volatile oil distilled from the wood of Santalum album. From India.

Characters.—Thick, pale yellow; odour strongly aromatic; flavour pungent, spicy. Readily soluble in alcohol. Contains two bodies, $C_{15}H_{24}O$ and $C_{15}H_{26}O$. *Dose*, 10 to 30 min., in capsules or as emulsion.

ACTION AND USES.

Oil of Sandal Wood **resembles Copaiva** in its action and uses, but is more easily taken. (*See* page 264.)

THYMELACEÆ.

Mezerei Cortex.—MEZEREON BARK. The dried bark of Daphne Mezereum, or of Daphne Laureola. British.

Characters.—Long, thin, flattened strips, folded or rolled into disks; or small quills. Internally whitish, silky, very tough; externally covered by a brown corky layer. No marked odour; taste burning, acrid.

Composition.—Mezereon contains an active acrid *resin*, the anhydride of a resinous acid *mezereinic acid;* an inert *fixed oil;* and a glucoside *daphnin*, $C_{31}H_{34}O_{19}$, also probably inactive.

Preparation.

Extractum Mezerei Æthereum.—Made by macerating in Ether a spirituous extract, and evaporating.

From Extractum Mezerei Æthereum is prepared:

Linimentum Sinapis Compositum.—8 gr. in 1 fl.oz.

Mezereon is an ingredient of Decoctum Sarsæ Compositum.

ACTION AND USES.

Mezereon is a powerful **local irritant**, like Mustard, **causing vesication** (*see* page 227). Internally it is **stimulant, diaphoretic, and alterative**: an irritant poison in large doses.

EUPHORBIACEÆ.

Cascarillæ Cortex.—CASCARILLA BARK. The dried bark of Croton Eluteria. From the Bahamas.

Characters.—Quills 1 to 3 or more inches long, $\frac{1}{6}$ to $\frac{1}{2}$ an inch in diameter; with a dull brown corky layer, coated with a silvery-white lichen. Fracture brown, short, resinous. Taste warm and nauseously bitter; odour agreeable, aromatic, especially when burned. *Substance resembling Cascarilla:* Pale Cinchona Bark; less white, smooth, and small.

Composition.—Cascarilla contains a complex mixture of *volatile oils* and *resins*, a crystalline bitter principle, *cascarillin*, $C_{12}H_{11}O_4$, *starch*, *tannin*, etc. *Incompatibles.* — Lime-water, metallic salts, mineral acids.

Preparations.

1. **Infusum Cascarillæ.**—1 in 10. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Cascarillæ.**—1 in 8 of *Proof* Spirit. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

Cascarilla acts in virtue of the aromatic oils and the bitter principle which it contains. It is a pleasant and useful **aromatic bitter stomachic.**

Oleum Crotonis.—CROTON OIL. The oil expressed in Britain from the seeds of Croton Tiglium. From the East Indies.

Characters.—Brownish-yellow to dark reddish-brown, fluorescent; consistence viscid, increased by age; odour faint, peculiar, rancid, disagreeable; taste oily, acrid. Entirely soluble in alcohol.

Characters of the Seeds.—About the size of a grain of coffee, oval or oval-oblong, dull brownish-grey, without odour. *Substance resembling Croton Oil Seeds:* Castor Oil Seeds, which are bright, polished, and mottled.

Composition.—The active principle of Croton Oil is obscure; it is believed to contain a vesicating and a purgative principle distinct from each other. Several *fixed oils* (olein, palmitin, stearin, myristin, and laurin), as well as their free acids, have been extracted from it; and several *volatile acids* (1 per cent. in all), which give its odour to Croton Oil, viz. acetic, butyric, valerianic, and tiglic ($HC_5H_7O_2$) acids, and are formed from the fixed oils after extraction. *Impurities.*—Other fixed oils.

Dose, ⅓ to 1 min. placed on the tongue or given on a soft lump of sugar.

Preparation.

Linimentum Crotonis.—1; Oil of Cajuput, 3½; Spirit, 3½.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Croton Oil is a **powerful irritant** to the skin; causing a burning sensation and redness, followed by a crop of papules and finally severe pustules. These last for days, heal by scabbing, and may leave unsightly cicatrices. The Liniment is much less used than formerly as a counter-irritant in affections of internal parts, especially the lungs and joints; occasionally in ringworm.

Internally, also, Croton Oil is a powerful irritant, causing burning in the throat, heat in the epigastrium, possibly nausea, and purgation. It acts as a very rapid **drastic cathartic,** with some pain, producing a motion within 1 to 2 hours, which is partly solid; the effect being repeated several times during the next twelve hours in a more liquid form. The irritant effect consists chiefly in direct inflammation of the mucous membrane, with increased watery transudation, heightened peristaltic action, and probably glandular (not biliary) hypersecretion. The muscular excitement and consequent griping, however, commence before the Oil has reached the duodenum, to be acted on by the pancreatic juice and bile, and are, therefore, partly reflex acts, originating in irritation of the gastric nerves, section of the vagi postponing its purgative effect in animals. This accounts for the rapid action of the drug.

Croton Oil is used when a speedy and complete evacuation of the bowels, and a diminution of the arterial pressure, are demanded. It is a proper purgative in some cases of apoplexy; in intestinal obstruction from impacted fæces; or in constipation where other purgatives have failed and an organic obstacle does not exist. The smallness of the dose, which can be put in food, renders it a convenient purgative for insane or unconscious patients. Croton Oil must be given with great care; and is inadmissible in feeble subjects, in organic obstruction, and in inflammatory states of the stomach and intestines.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

Croton Oil or its products are occasionally absorbed, and may cause disturbance of the heart and nervous centres.

Oleum Ricini.—CASTOR OIL. The oil expressed from the seeds of Ricinus communis. Chiefly from Calcutta.

Characters.—Viscid, colourless or pale straw-yellow; having scarcely any odour; taste mild at first, subsequently acrid and unpleasant. Entirely soluble in one volume of absolute alcohol, and in two volumes of rectified spirit. Sp. gr. 0·96.

Characters of the Seeds.—Oval, somewhat compressed, smooth and shining, grey, marbled with reddish-brown or blackish-brown spots and stripes. *Substance resembling Castor Oil Seeds:* Croton Oil Seeds (q.v.).

Composition.—The bulk of Castor Oil is believed to consist of *ricinoleate of glyceryl*, $C_3H_5,3C_{18}H_{33}O_3$. Palmitin, stearin, cholesterin, and possibly a resin and an alkaloid also occur in small quantity. *Dose*, 1 to 8 fl.dr.

Preparations.

Oleum Ricini is contained in: Collodium Flexile (1 in 51), Linimentum Sinapis Compositum (1 in 8), and Pilula Hydrargyri Subchloridi Composita (1 in 5).

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, pure Castor Oil is bland, like Almond Oil; and is applied as a local sedative and protective, *e.g.* in injury of the conjunctiva by quicklime.

Internally.—Castor Oil, if pure, is perfectly non-irritant until it reaches the duodenum, where it is decomposed by the pancreatic juice, and the ricinoleic acid at once comes into action. If the Oil be rancid, it will irritate the stomach and cause nausea and vomiting.

Castor Oil is a **simple purgative**, at once rapid and certain, mild and painless; producing one or more liquid but not watery stools in four to six hours, **followed by a sedative effect.** It is believed to stimulate the muscular coat and intestinal glands, but not the liver. It purges also as enema. Castor Oil is used as the best of all simple purgatives when only a free evacuation of the bowels is desired. It can be given in all conditions where a laxative is permissible; and it is therefore specially employed in the treatment of diarrhœa due to the presence of indigestible or undigested food in the bowels, in the constipation of typhoid fever, after abdominal operations, in pregnancy, and *post-partum*. It is a valuable purgative for children and for the old and infirm. In some forms of indigestion in infants, small doses (5 min. for an infant) may be given three or four times a day for days or even weeks, as an emulsion, with the best result. Small doses of Tincture of Opium are sometimes combined with Castor Oil.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION.

Ricinoleic acid enters the blood and tissues, and leaves the body in the excretions, including the milk, which purges infants at the breast.

The *Leaves* of the Castor Oil Tree, applied locally to the mamma as a poultice, are said to be galactagogue.

Kamala.—KAMALA. A powder which consists of the minute glands and hairs from the surface of the fruits of Mallotus philippinensis. From India.

Characters.—A fine granular, mobile, brick-red or madder powder; nearly tasteless and inodorous. Water has scarcely any effect on it; it forms deep red solutions with alcohol, ether, or chloroform. Microscopically it consists of garnet-red glands, and nearly colourless stellate hairs. *Impurities.*—Sand or earth, detected by amount of ash. *Resembles* Red Oxide of Mercury, but is not heavy.

Composition.—Kamala contains an active resin, *rottlerin*, allied to koussin (see *Cusso*), *tannin*, red colouring matter, etc.

Dose.—30 gr. to ¼ oz., as an electuary with Tamarinds.

ACTION AND USES.

Kamala is an **anthelmintic** and gastro-intestinal irritant, sometimes causing nausea, vomiting, colic, and diarrhœa. It is used to expel the tape-worm, lumbricoid, and oxyuris.

PIPERACEÆ.

Piper Nigrum.—BLACK PEPPER. The dried unripe fruit of Piper nigrum. From the East Indies.

Characters.—Roundish, about ⅕ of an inch in diameter; pericarp thin, blackish-brown, wrinkled; with a hard, smooth, roundish, brownish or grey seed. Odour aromatic; taste pungent, bitterish. *Substances resembling Black Pepper:* Pimento, which has calyx; Cubebs, which is stalked.

Composition.—Pepper contains a *volatile oil*, isomeric with Turpentine, with the odour of pepper; a complex *resin;* and a tasteless crystalline alkaloid, *piperine*, $C_{17}H_{19}NO_3$ (that is, isomeric with Morphine), which can be broken up into piperic acid and piperidine, a liquid alkaloid, homologous with conine, with powerful odour and taste. *Dose*, 5 to 20 gr.

Preparation.

Confectio Piperis.—1 in 10, with Caraway and Honey. *Dose*, 1 to 2 dr.

Piper is also contained in Pulvis Opii Compositus (1 in 7½) and in Confectio Opii (1 in 30).

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, Pepper is a domestic rubefacient, anodyne, and counter-irritant, like Mustard.

Internally, it acts as a **local stimulant and aromatic** in the mouth, stomach, and intestine. As a condiment, it assists gastric digestion like other substances of the same class.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

The volatile oil of Pepper acts like its allies. Piperine is believed to possess the antiperiodic and antipyretic action of Quinine; and Pepper was once a domestic remedy for ague, which may still be used in cases where the appetite fails.

3. REMOTE LOCAL ACTION AND USES.

Some of the constituents of Pepper are excreted by the kidneys, and probably by the intestinal mucous membrane, and act as **remote local stimulants** of the circulation and nutrition in the **urethra and rectum.** Pepper is occasionally used in gleet; but much more extensively for hæmorrhoids and other diseases of the rectum.

Cubeba.—CUBEBS. The dried unripe full-grown fruit of Piper Cubeba. From Java.

Characters.—Globular, about $\frac{1}{6}$ of an inch in diameter, blackish or greyish-brown, wrinkled, tapering below into a rounded stalk. Beneath the skin is a hard shell, sometimes containing a seed. Taste warm, aromatic, bitter; odour strong, aromatic. A cold decoction is coloured indigo-blue by iodine. *Substances resembling Cubebs:* Pimento and Pepper, which have no stalk.

Composition.—Cubebs consists of 6 to 15 per cent. of the official *volatile oil;* 2 per cent. of a neutral, odourless, and tasteless body, insoluble in water, *cubebin*, $C_{33}H_{34}O_{10}$; 6 per cent. of a *resin* containing *cubebic acid;* some *piperine;* a fatty oil; and gum. *Dose*, 30 to 120 gr.

Preparations.

1. **Oleo-Resina Cubebæ.**—Made by percolation with Ether, evaporation, and decantation. *Dose*, 5 to 30 min.
2. **Tinctura Cubebæ.**—1 in 8 of Spirit. *Dose*, $\frac{1}{2}$ to 2 fl. dr.

From Cubeba is made:

Oleum Cubebæ.—The Oil distilled in Britain from Cubebs. Colourless or greenish yellow, with the odour of Cubebs. Consists chiefly of *cubebene*, $C_{15}H_{24}$, with a stearoptene, and a little terpene. *Dose*, 5 to 20 min., with mucilage.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action of Cubebs closely resembles that of common Pepper, but different parts of the body are affected in different degrees. Cubebs is an aromatic stomachic, in small doses; in large doses it is apt to derange the digestion; in very large doses it is a gastro-intestinal irritant. It is sometimes applied to the pharynx in chronic inflammation; very rarely it is given in chronic dyspepsia.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

The active principles of Cubebs enter the blood, and thence the tissues. Large doses probably have an action similar to Turpentine, but no use is made of it on this account.

3. REMOTE LOCAL ACTION AND USES.

The principal effects of Cubeb Pepper are produced when it is leaving the body by the kidneys and urinary passages, the skin, and the respiratory organs. In this respect it closely resembles Copaiva, and is used in the same class of cases with it. Thus, it is a diuretic, acting directly on the renal cells, especially when given as the Oleo-resin. The cubebic acid is excreted in the urine as a salt, from which it may be precipitated by nitric acid; and this **stimulates and disinfects the genito-urinary passages** with which it comes in contact. The sweat and the bronchial mucus are both increased, and sometimes an eruption appears on the skin.

Cubebs is chiefly used in gonorrhœa and vesical affections. It is decidedly less unpleasant than Copaiva, and much less liable to disturb digestion. Sometimes it is prescribed for chronic bronchitis.

Maticæ Folia.—MATICO LEAVES. The dried leaves of Piper angustifolium. From Peru.

Characters.—Leaves more or less broken, folded, compressed into a brittle mass; mixed with jointed stems, flowers, and fruit. Each from 4 to 8 inches long, oblong-lanceolate, unequal at the base, greenish-yellow, reticulated with sunken veins and tessellated above; the veins prominent beneath, the depressions being clothed with hairs. Taste aromatic, bitterish; odour pleasant, feebly aromatic. *Substance resembling Matico:* Digitalis. (*See* page 341.)

Composition.—Matico contains a quantity of *volatile oil, artanthic acid* (crystalline), *resin*, and *tannic acid.*

Preparation.

Infusum Maticæ.—1 in 20. *Dose,* 1 to 4 fl.oz.

ACTION AND USES.

Matico is said to **resemble pepper and cubebs** very closely in its action, and has been given in the same class of cases, but is not in general use. The physical characters of the under surface of the leaf render it a **local hæmostatic,** when applied to incised wounds, as it facilitates coagulation.

SALICACEÆ.

Salicinum.—Salicin, $C_{13}H_{18}O_7$. A glucoside obtained from the bark of Salix alba, and other species of Salix and of Populus. *Source.*—Made by treating the bark with hot water, removing tannin and colouring matter from the decoction, evaporating, purifying, and recrystallising.

Characters. — Colourless, shining, very bitter crystals. *Solubility :* 1 in 28 of water; 1 in about 50 of spirit; insoluble in ether. Sulphuric Acid colours it red. Heated with K_2CrO_4,CrO_3, a few drops of H_2SO_4, and some water, it yields vapours of an oil having the odour of meadow-sweet. Melts when heated, and emits similar vapours. *Dose,* 3 to 20 gr.

Acidum Salicylicum. — Salicylic Acid, $HC_7H_5O_3$. *Source.*—Obtained from natural Salicylates, such as the oils of Wintergreen, Gaultheria procumbens (N.O. Ericaceæ), and Sweet Birch, Betula lenta (N.O. Betulaceæ); or by the combination of the elements of Carbolic Acid with those of Carbonic Acid Gas, and subsequent purification.

Characters and tests.—White needles; inodorous, irritating to the nostrils; taste sweetish, then acid. *Solubility :* 1 in 600 of Water; readily in alcohol, ether, and hot water; also in solutions of citrate or acetate of ammonium, phosphate of sodium, or borax. Aqueous solutions give with perchloride of iron a reddish-violet colour. *Impurities.*—Iron and organic matter; alcoholic solutions evaporating spontaneously should leave a perfectly white residue. *Dose,* 5 to 30 gr.

Preparation.

Unguentum Acidi Salicylici.—1 to 27 of Paraffin.

From Acidum Salicylicum is made :

Sodii Salicylas.—Salicylate of Sodium, $(NaC_7H_5O_3)_2,H_2O$. *Source.*—Made by the action of Salicylic Acid on Carbonate of Sodium or on Caustic Soda.

Characters.—Small, nearly colourless, crystalline scales; inodorous; taste sweetish, saline. *Solubility :* slightly in alcohol, readily in water; solutions neutral or faintly acid. *Impurities.*—Sulphates, chlorides, carbonates. *Dose,* 10 to 30 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Salicylic Acid acts as an **antiseptic and disinfectant**, not inferior to Carbolic Acid, 1 part in 60 killing developed bacteria. At the same time it stimulates the local circulation. It is extensively used as a surgical dressing in the form of cotton wool impregnated with the Acid by the aid of glycerine. On the contrary, Salicylate of Sodium has no antiseptic or disinfectant power, unless combined with a mineral acid to liberate the Salicylic Acid. Salicylic Acid in powder, diluted with talc, is an **anhidrotic**, checking local perspirations of the feet, or the general perspirations of phthisis. Neither substance is absorbed by the unbroken skin.

Internally.—Salicylic Acid causes sneezing and cough when applied to the nose or inhaled, like Benzoic Acid; and when admitted to the stomach is also a local irritant, causing heat, pain, nausea, and vomiting, unless in moderate doses, well-diluted. The Sodium salt is very much less irritant, and may be freely administered if pure. The latter drug is used for sarcinous vomiting and some cases of chronic dyspepsia with decomposition. Salicin is easily borne by the stomach. In the bowel it is partly converted into saligenin ($C_7H_8O_2$) and glucose; and the former is in turn broken up into salicyluric ($HC_9H_8NO_4$), salicylic, and salicylous ($HC_7H_5O_2$) acids.

2. ACTION IN THE BLOOD, AND ITS USES.

Salicylic Acid necessarily exists in the blood as the salicylate of sodium, being taken up with considerable rapidity. The Acid is possibly again liberated in part by the free carbonic acid of the plasma in inflamed parts of the body, and thus exerts its antiseptic action within the body; but this is doubtful. Either in the blood, or in some of the tissues, a portion unites with glycocoll (just like Benzoic Acid), and forms salicyluric acid (comparably with hippuric acid), thus: $HC_7H_5O_3 + C_2H_5NO_2$ (glycocoll) $= HC_9H_8NO_4$ (salicyluric acid) $+ H_2O$.

As regards Salicin, the decomposition begun in the bowel is continued in the blood.

3. SPECIFIC ACTION AND USES.

The action of Salicylic Acid and its Sodium salt in the tissues is identical, since the former is converted into the latter. A moderate dose causes increased cardiac action, flushing and warmth of the surface, perspiration, a full feeling in the head, tinnitus, deafness, impairment of vision, and possibly a slight fall of temperature, although the nitrogenous waste is said to be increased. Larger doses may cause delirium, especially with visual hallucinations; respiration is temporarily disturbed; the heart is depressed after the primary excitation; the vessels are relaxed, and the blood pressure falls; perspiration is increased; the peripheral nerves, both sensory and motor, are unaffected.

All these phenomena in the healthy subject, taken together, do not account for the remarkable effect of Salicylates upon the body temperature in pyrexia or fever, that is, as **powerful antipyretics.** Two or more moderate doses (15 to 20 gr.) within one or two hours reduce pyrexial temperatures several degrees, according to the disease and subject. It is therefore probable that the Salicylates act upon some *pathological* cause of pyrexia, possibly on the organisms of the specific fevers.

Salicylate of Sodium is employed in two allied but distinct classes of cases: 1. In pyrexia from any cause, such as typhoid fever, pneumonia, pyæmia, etc., it is a simple and powerful antipyretic. In this respect it is comparable with Quinine; only more rapid in its action, less lasting in its effects, and more depressant to the circulation. It may be given in these diseases in single full doses when the temperature exceeds a certain height, say 104° Fahr. 2. In acute rheumatism, Salicylate of Sodium is distinctly a specific (much as Quinine is a specific against malaria), reducing the temperature, relieving the pain, removing the swelling and other local symptoms, and shortening the duration of the disease. By thus curtailing the course of rheumatism, this drug may indirectly reduce the liability to cardiac and other complications; but it is of no great service directly in this respect. It is of no use in chronic rheumatism, nor in gout; of doubtful value in rheumatic sciatica. It may be given either in wafers or in solution; and is sometimes combined with Bicarbonate of Potassium in free doses (20 gr.). When the pyrexia declines, the dose of the Salicylate must be most gradually reduced, as relapses are extremely common after it has been discontinued.

Diphtheria and diabetes are said to have been successfully treated with Salicylates.

Salicin may be used for the same purposes as the Salicylates; its action, if less powerful, being better sustained, and the cardiac and vascular depression less marked.

4. REMOTE LOCAL ACTION AND USES.

Salicylic Acid is but slowly excreted in the urine, sweat, saliva, bile, and mucous secretions generally: mostly as salicylates or the free acid, partly as salicyluric acid. Salicin and Salicylic Acid occasionally induce a morbilliform eruption.

Its most important action remotely is on the kidneys and urinary passages, where it is a stimulant and disinfectant, at the same time **increasing the acidity of the secretion.** It is thus adapted for the treatment of chronic inflammatory affections of the bladder, with foul alkaline urine and phosphatic deposits. Sometimes however, it so irritates the kidney as to cause albuminuria, and even hæmaturia; and it must be used with great caution, when given for these or other purposes, if renal or hepatic disease be present, and in aged persons.

LIQUIDAMBARACEÆ.

Styrax Præparatus.—PREPARED STORAX. A balsam prepared from the inner bark of Liquidambar orientalis. Purified by solution in spirit, filtration, and evaporation.

Characters and tests. — A brownish-yellow, semifluid balsam; odour strong, agreeable; taste balsamic. Heated it becomes more liquid; boiled with solution of K_2CrO_4,CrO_3 and H_2SO_4 it evolves the odour of oil of bitter almonds.

Composition.—Storax consists of a volatile oil, *styrol*, C_8H_8; *cinnamic acid; cinnamate of cinnamyl* (styracin), C_8H_7CO,OC_9H_9; and various *resins.* Cinnamic acid, C_8H_7COOH, which occurs also in Cinnamon and the Balsams of Peru and Tolu, is a colourless, odourless, crystalline body, closely allied to Benzoic Acid, into which it can be oxydised. *Dose*, 5 to 20 gr.

Storax is contained in Tinctura Benzoini Composita.—Nearly 33 gr. in 1 fl.oz.

ACTION AND USES.

Storax is a **local and remote stimulant, antiseptic, and disinfectant,** like Benzoin and the Balsams of Peru and Tolu. It is used for scabies and phthiriasis. (*See* page 255.)

HAMAMELACEÆ.

Hamamelis. (*Not official.*) — The leaves of Hamamelis virginica, the Witch Hazel, collected in autumn. From the United States.

Characters.—Shortly petiolate, 4 inches long, obovate or oval, oblique at base, sinuate-toothed, nearly smooth; inodorous; astringent and bitter.

Composition.—Hamamelis contains traces of *tannic acid*, bitter and odorous matters, and an unknown active principle.

Non-official Preparations.

HAMAMELIN, a powdered Extractive; *Dose*, ½ to 2 gr. TINCTURE (1 to 10); *Dose*, 2 to 5 min. LIQUID EXTRACT; *Dose*, 10 min. to 2 fl.dr.

ACTION AND USES.

Hamamelis is an **astringent and hæmostatic** both locally and remotely. It is useful in hæmorrhages from the nose, lungs, rectum, or uterus.

CUPULIFERÆ.

Quercûs Cortex.—OAK BARK. The dried bark of the smaller branches and young stems of Quercus Robur. Collected in spring, from trees growing in Britain.

Characters.—Quills covered with a smooth shining, silvery variegated with brown, corky layer; internally brownish, longitudinally striated; fracture tough, fibrous; no marked odour, taste very astringent.

Substance resembling Oak Bark: Pale Cinchona Bark; which is bitter.

Composition.—Oak Bark contains 4 to 20 per cent. of a variety of *tannic acid*, *pectin*, and other constituents of plants. *Incompatibles.*—Those of tannic acid

Preparation.

Decoctum Quercûs.—1 in 16.

Galla.—GALLS. Excrescences on Quercus lusitanica, caused by the puncture and deposit of ova of Cynips Gallæ tinctoriæ.

Characters.—Hard, heavy, subglobular; from ½ to ¾ inch or more in diameter; tuberculated on the surface, the tubercles and intervening spaces smooth; dark blueish-green on the surface; yellowish-white within, with a small central cavity. No odour; taste intensely astringent, then sweetish.

Composition.—Galls contain from 25 to 65 per cent. of *tannic acid*, about 5 per cent. of *gallic acid*, and other less important constituents.

Preparations.

1. **Tinctura Gallæ.**—1 in 8 of *Proof* Spirit. *Dose,* ½ to 2 fl.dr.
2. **Unguentum Gallæ.**—1 in 6½ of Benzoated Lard.

From Unguentum Gallæ is prepared:

UNGUENTUM GALLÆ CUM OPIO.—13⅔; Opium, 1.

From Galla are also made:

3. **Acidum Tannicum.**—Tannic Acid. Tannin. $C_{27}H_{22}O_{17}$. An acid extracted from Galls.

Source.—Made by exposing powdered Galls to a damp atmosphere for three days; macerating with ether and water; separating the liquid portion by pressure, partially evaporating, and drying the same.

Characters.—Pale yellow vesicular masses, or thin glistening scales; taste strongly astringent; reaction acid. *Solubility:* 10 in 8 of water or spirit, very sparingly in pure ether, 1 in 3 of glycerine. *Incompatibles.*—Gelatine (which it precipitates yellowish-white, distinguishing it from Gallic Acid); mineral acids; alkalies; salts of antimony, lead, and silver; persalts of iron (which it precipitates blueish-black); most alkaloids; vegetable emulsions. *Dose,* 2 to 10 gr., or more.

Preparations.

a. **Glycerinum Acidi Tannici.**—1 to 4 with the aid of heat.
b. **Suppositoria Acidi Tannici.**—3 gr., with Oil of Theobroma 12 gr., in each.
c. **Suppositoria Acidi Tannici cum Sapone.**—3 gr.; Glycerine of Starch, 2½ gr.; Curd Soap, 8⅓ gr.; Starch, *q.s.*, in each.
d. **Trochisci Acidi Tannici.**—½ gr. in each; with Tincture of Tolu, Sugar, Gum, and Water. *Dose,* 1 to 6.

4. **Acidum Gallicum.**—Gallic Acid. $H_3C_7H_3O_5, H_2O$. An acid prepared from galls.

Source.—Made by boiling 1 part of powdered Galls with 4 fl. parts of Diluted Sulphuric Acid for half an hour; straining; and purifying the crystalline product.

Characters.—White or pale fawn, silky needles; taste simply acid. *Solubility:* 1 in 100 of cold, 1 in 3 of boiling water; 1 in 8 of spirit; 1 in 20 of glycerine. Gives a blueish-black precipitate with *per*-salts, but simply darkens *proto*-salts, of iron. *Resembles* Tannic Acid, but has no astringent taste, and does not precipitate solutions of gelatine. *Incompatibles.*—Spiritus Ætheris Nitrosi; metallic salts, including *per*-salts of iron. *Dose*, 2 to 10 gr., or more.

Preparation.

Glycerinum Acidi Gallici.—1 to 4, with the aid of heat.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The action of Tannic Acid, and of the many official substances containing it, depends chiefly upon its property of precipitating albumen and gelatine. When applied to the broken skin or to exposed mucous surfaces, it condenses or "tans" the albuminous and connective tissues, and coagulates the fluids pervading the solid elements (an action which in the dead skin converts the whole into leather). At the same time the sensibility of the nerves is reduced. The vessels of the part are compressed by the constringed connective tissues to such a degree that their size is indirectly reduced; the circulation through them is diminished; and any hæmorrhage from them is arrested by pressure and by coagulation of the blood by the Acid. If a "passive" discharge of plasma and leucocytes be escaping from their walls, as in chronic inflammation, the exudation is stopped. Thus Tannic Acid is a powerful indirect **styptic and a constringent.** Broken surfaces, such as ulcers, have their superficial layers of cells condensed, and the discharge coagulated, with some **disinfectant** effect, the action as a whole promoting healing. It is an important fact that Tannic Acid does not *actively* contract blood-vessels, like Lead and Silver; on the contrary, it dilates them; but its *indirect* constringent influence more than neutralises this effect.

There is hardly a limit to the application of Tannic Acid, and preparations containing it, as styptics and astringents. Superficial hæmorrhage from small wounds, the nose, gums, throat, etc., and chronic or subacute inflammatory discharges from the skin, eyes, nose, urethra, vagina, womb, or rectum, may all be treated with it. The Acid may be used solid, being dusted or insufflated on the part; applied in solution as injection, lotion, etc.; or inserted into canals or cavities as bougies or the Suppositories. The two Ointments of Galls are favourite applications to hæmorrhoids.

Internally.—In the mouth, Tannic Acid produces its peculiar "taste," with a sensation of astringency, dryness, roughness, stiffness of the tongue and throat, and thirst; the parts being constringed and partially anæsthetised, and the other effects produced, as described externally. Preparations containing this drug are in much request in chronic sore throat with a relaxed condition of the uvula, pharynx, and larynx, slight catarrh, cough, and occasional slight bleeding. The Trochisci, gargles, sprays, or the Glycerine applied with a brush, may be used in different cases.

In the stomach, Tannin precipitates the pepsin with the albumens of the gastric juice; and, if in quantity, will interfere with digestion by this means, as well as by constringing the mucosa, reducing the circulation, and diminishing the secretion. On the contrary, if a chronic mucous catarrh be present, causing dyspepsia, Tannin in the form of Pulvis Catechu Compositus, etc., will give relief by arresting the morbid process, on the principles already discussed. Hæmorrhage from ulcer of the stomach is often successfully treated by free (1 dr.) doses of the Acid, which acts as a direct styptic. In the stomach another highly important use is made of the drug, viz. as an antidote to antimony and such alkaloids as morphine, nicotine, strychnine, etc.; a strong infusion of tea being given if no other tannate be at hand. An emetic or purgative should afterwards be given in alkaloidal poisoning, as the compounds with Tannic Acid are not perfectly insoluble.

The astringent effect of Tannin is continued in the intestines, where it and its compounds are the most popular remedies for diarrhœa, whether alone or combined with other astringents, with antacids such as Chalk, or anodynes such as Opium. Intestinal hæmorrhage may sometimes be arrested by the same means. During its passage along the alimentary canal, part of the Tannin is converted into gallic acid, which enters the blood; the rest is excreted in the fæces:

$$\text{Tannic Acid} + \text{water} = \text{gallic acid} + \text{glucose}$$
$$C_{27}H_{22}O_{17} + 4H_2O = 3H_3C_7H_3O_5 + C_6H_{12}O_6.$$

Gallic Acid possesses no local astringent properties, and is therefore seldom if ever given for immediate local purposes.

2. ACTION ON THE BLOOD.

Entering the circulation as Gallic Acid, the preparations of Tannin are not certainly known to have any further astringent effect on the vessels, any antiseptic action, nor coagulating influence on the blood. If injected directly into the veins, Tannic Acid proves rapidly fatal by clotting and embolism.

3. SPECIFIC ACTION AND USES.

The action of these substances on the tissues must depend entirely on the Gallic Acid. This is generally regarded as a specific astringent and styptic, arresting chronic discharges from internal and distant parts, such as the uterus and rectum, and checking bleeding, especially hæmoptysis. For these purposes Gallic Acid is much used, and should be given in full doses, even up to 1 drachm at a time if hæmorrhage be urgent. It must be confessed that some authorities do not believe in this action nor in this use of the drug.

4. REMOTE LOCAL ACTION AND USES.

Tannic and Gallic Acids are rapidly excreted, chiefly as Gallic Acid, partly as pyrogallic acid, in the urine, which is darkened in tint. No remote disinfectant effect is to be obtained in the kidneys or bladder; nor is Gallic Acid now believed to diminish the albuminuria of Bright's disease. Some hold that it arrests renal hæmorrhage; but in this, and in all kinds of hæmorrhage, there is a constant possible source of error, from the fact that the spontaneous arrest of bleeding is extremely common. Gallic Acid has also been used in night sweating, with doubtful success.

Acidum Pyrogallicum. — PYROGALLIC ACID. $C_6H_3(OH)_3$. (*Not official.*) A body obtained from gallic or tannic acid by carefully heating.

Characters.—Very small, shining, colourless crystals, becoming black on exposure; odourless; insipid; not acid to test paper; readily soluble in water. *Dose*, ½ to 1½ gr.

ACTION AND USES.

Pyrogallic Acid has a powerful affinity for oxygen, and is thus **antiseptic and disinfectant** (in 1 to 2½ per cent. solutions). It stains the hair dark without injuring its structure. It also acts as a powerful but painful local stimulant, which will destroy excessive cutaneous growths, and may be used (60 gr. to 1 oz. of Lard) in lupus, in epithelial cancer, and in psoriasis, but only when the patches of disease are *small.*

Whether applied freely to the skin, or given internally in large doses, Pyrogallic Acid has a destructive influence on the red corpuscles of the blood, which assumes a brownish appearance and readily coagulates. Vomiting, purging, bloody urine, nervous and general depression, are the results of this blood change, which may prove fatal; hence the caution given in the last paragraph. Pyrogallic Acid produces the same remarkable effect on the growth of bone as Phosphorus and Arsenic. *See* page 106.

MORACEÆ.

Ficus.—FIG. The dried fruit of Ficus Carica. Imported from Smyrna.

Composition.—Figs contain *sugar* and *mucilaginous* substances.

Figs are contained in Confectio Sennæ, 12 in 75.

ACTION AND USES.

The dried Fig is a very pleasant **demulcent and nutritive** substance with **laxative** properties, and may be ordered as an article of diet in habitual constipation. It is sometimes used locally as a poultice to gum-boils.

Mori Succus.—MULBERRY JUICE. The Juice of the ripe fruit of Morus nigra.

Characters.—Colour dark violet; odour faint; taste acidulous, sweet, refreshing.

Preparation.

Syrupus Mori.—Juice, Sugar, and Spirit. *Dose,* 1 to 2 fl.dr.

ACTION AND USE.

Mulberry Juice is a **flavouring and colouring agent.**

CANNABINACEÆ.

Cannabis Indica.—INDIAN HEMP. The dried flowering or fruiting tops of the female plants of Cannabis sativa, grown in India, and from which the resin has not been removed.

Characters.—Small masses, 1½ to 2½ inches long, consisting of tops of alternate branches bearing remains of flowers, leaves, and a few ripe fruits, the whole compressed by adhesive resinous matter; or straight, stiff, woody stems several inches long, surrounded by the branched flower stalks. Rough, very brittle, dusky-green; odour faint, peculiar, narcotic, not unpleasant; nearly tasteless.

Composition.—Cannabis Indica has yielded an amorphous *resin;* a glucoside, *cannabin;* an active principle, *cannabinon;* a volatile alkaloid, *cannabinine;* another alkaloid, *tetano-cannabine;* and a volatile oil, *cannabene. Incompatibles.*—Water and watery infusions, which precipitate the resin.

Preparations.

Extractum Cannabis Indicæ.—Alcoholic. 6 in 1. *Dose*, ¼ to 1 gr.

From the Extract is prepared:

TINCTURA CANNABIS INDICÆ.—1 of Extract to 20 of Spirit. *Dose*, 5 to 20 min., with 1 fl.dr. of Mucilage.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION, AND ACTION IN THE BLOOD.

Positive knowledge on these points is wanting. Cannabis Indica is never used *externally. Internally* the Extract forms a useful corrective of some griping purgatives, such as Podophyllin and Colocynth. It does not derange the stomach and intestines like Opium.

2. SPECIFIC ACTION AND USES.

The action of Cannabis Indica is ill understood. The official preparations chiefly affect the convolutions, producing a species of intoxication; disordered consciousness of personality, locality, and time; and exaltation of the feelings, with pleasing grandiose ideas and hallucinations. Noisy, restless delirium supervenes, with muscular excitement or more commonly sleep; therewith pain may be relieved. The heart and the blood-vessels appear to be first stimulated and afterwards depressed. The physiological effects of the several constituents have not been fully determined. Cannabin and Cannabinon are the most important, the latter especially causing the intoxication. Tetano-cannabine is a convulsant.

Cannabis Indica was formerly used as a hypnotic and anodyne, when Opium disagreed or had been taken in excess; but, from its uncertainty, it has been generally replaced by Chloral. Combined with Bromide of Potassium, it is useful in mania. More frequently it is given as an indirect anodyne and antispasmodic in dysmenorrhœa, menorrhagia, and hysteria. It may also be tried in neuralgia, and in spasmodic asthma (as cigarettes), when other remedies fail.

3. REMOTE LOCAL ACTION.

Nothing is definitely known respecting the excretion of Cannabis Indica. It increases the amount of urine, probably through the blood pressure.

Lupulus.—HOP. The dried strobiles of Humulus lupulus, cultivated in England.

Characters.—Compressed and broken in commercial specimens. When entire, about 1¼ inch long; oblong-ovoid; consisting of many thin greenish-yellow or brownish membranous imbricated scales or bracts; each having at its base a small rounded achene sprinkled with brownish-yellow glands (lupulin), the whole attached to a hairy undulated axis. Odour aromatic; taste bitter, aromatic, feebly astringent.

Composition.—Hops contain an aromatic volatile oil, *valerol*, $C_6H_{10}O$, on which its odour depends; 11 per cent. of a crystalline bitter principle, *lupulinic acid*, $C_{32}H_{50}O_7$; possibly a liquid volatile alkaloid, *lupuline*; and *tannin.* *Incompatibles.*—Mineral acids; metallic salts.

Preparations.

1. **Extractum Lupuli.** Alcoholic and aqueous.—4 in 1. *Dose*, 5 to 15 gr.
2. **Infusum Lupuli.**—1 in 20. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Lupuli.**—1 in 8 of *Proof* Spirit. *Dose*, ½ to 2 fl.dr.

Lupulinum.—LUPULIN. A glandular powder obtained from the dried strobiles of Humulus lupulus.

Characters.—A granular, bright brownish-yellow powder, consisting microscopically of minute, globular-top-shaped, reticulated, translucent, shining glands. Odour and taste those of Hop. *Impurities.*—Dust, yielding excess of ash. *Dose*, 2 to 5 gr.

ACTION AND USES.

The action and uses of the Hop depend upon the presence of its two important constituents, which exert the characteristic effects of the class to which they respectively belong. (1) The primary stimulant, and secondary sedative and soporific effects of the **aromatic** oil, associated with those of alcohol, are seen in ales and beers, less distinctly in the official preparations. The **stomachic and tonic** effect of the hop-bitter, lupulinic acid, is equally familiar in wholesome bitter ale. Ale is moderately laxative and **diuretic**, by virtue of the essential oil and alcohol.

Hop is used medicinally chiefly in the form of pure bitter ales, to produce the effects just indicated, especially to rouse and improve the appetite during convalescence and in low states of the system, and to promote sleep. The official preparations sometimes relieve the craving of alcoholism, and act as anaphrodisiacs. Lupulin is given as a hypnotic.

CONIFERÆ.

Oleum Terebinthinæ.—OIL OF TURPENTINE. The oil distilled, usually by aid of steam, from the oleo-resin (turpentine) obtained from Pinus australis, Pinus tæda, and sometimes from Pinus pinaster and Pinus sylvestris; rectified if necessary.

Characters and tests.—Limpid, colourless; odour strong, peculiar, varying in the different kinds; taste pungent, bitterish. Boils about 320° Fahr.; almost entirely distils below 356° Fahr. Sp. gr. 0·864. Neutral. Mixes with other volatile and fixed oils, and dissolves resins, wax, sulphur, phosphorus, and iodine. Solubility, 1 in 10 of rectified spirit.

Composition.—The oleo-resin, common turpentine, as it is formed on trees, is an impure solution of *resin* in 15 to 30 per cent. of the official *volatile oil.* The Oil of Turpentine, $C_{10}H_{16}$, with the characters just described, readily absorbs oxygen on exposure to the air, and is converted into the resin, certain other acids, carbonic acid, and ozone, which thus increase at the expense of the oil; the mixture constituting the oleo-resin. When the latter is distilled, after agitation with lime-water, the volatile oil passes over, leaving the resin behind. Oil of Turpentine is isomeric with a number of volatile oils, or of their constituents, already met with in the materia medica. *Dose,* 10 to 30 min.; as an anthelmintic, 2 to 4 fl.dr.

Preparations.

1. **Confectio Terebinthinæ.**—1; Liquorice, 1; Honey, 2. *Dose,* 60 to 120 gr.
2. **Enema Terebinthinæ.**—1 oz.; Mucilage of Starch, 15 oz. For one enema.
3. **Linimentum Terebinthinæ.**—16, with Camphor, 1; rubbed up with Soft Soap, 2, mixed with Water, 2.
4. **Linimentum Terebinthinæ Aceticum.**—4; Glacial Acetic Acid, 1; Liniment of Camphor, 4.
5. **Unguentum Terebinthinæ.**—8; Resin, 1; Yellow Wax, 4; Lard, 4.
6. (*Not official.*) Terebene.—An isomer of Oil of Turpentine,

produced by the action of H_2SO_4 on the latter, and distillation. A colourless liquid, with the odour of fresh-sawn pinewood. Not miscible with water. *Dose*, 5 to 30 min. in emulsion.

Resina.—RESIN. The residue left after distillation of Oil of Turpentine from the crude oleo-resin (turpentine) of various species of Pinus.

Characters.—Translucent, yellowish, brittle, pulverisable; fracture shining; odour and taste faintly terebinthinate. Easily fusible; burns with a dense yellow flame and much smoke.

Composition.—Resin consists of three isomeric resinous acids, *pinic*, *sylvic*, and *pimaric*, $HC_{20}H_{29}O_2$, and a trace of *oil of turpentine.*

Preparations.

1. **Emplastrum Resinæ.**—2; Lead Plaster, 16; Curd Soap, 1.
2. **Unguentum Resinæ.**—4; Yellow Wax, 2; Simple Ointment, 8; Almond Oil, 1.

Resin is contained in many other Plasters, in Unguentum Terebinthinæ, and in Charta Epispastica.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied to the skin or exposed mucous surfaces, Turpentine is **antiseptic and disinfectant**, and produces a sense of heat and redness, followed by burning and vesication, the local circulation being stimulated, and the local nerves first irritated and then depressed. Resin is a mild local stimulant and disinfectant. Turpentine is therefore in very extensive use as a **local stimulant and counter-irritant**: (*a*) In painful affections of a local kind, such as chronic rheumatism of muscles or joints, and neuralgia, in the form of the Liniments, the Resin Plaster, and Turpentine stupes. (*b*) In affections of deep parts, to act reflexly on the vessels and nerves; for instance, to relieve bronchitis by being rubbed on the chest, meteorism by application to the abdomen as stupes, or affections of joints by inunction over them. (*c*) As a disinfectant and stimulant it may be applied to ulcers and wounds, the Unguentum Resinæ being very useful for this purpose, whilst the pure Oil is applied to hospital gangrene. Turpentine is absorbed by the unbroken skin, and its action in meteorism may be partly accounted for in this way, as we shall see. Resin also gives a consistence and adhesiveness to the many plasters of which it is an ingredient.

Internally.—In the stomach, as externally, Oil of Turpentine is disinfectant, stimulant to the vessels, sedative to the local nerves, and reflexly stimulant, at least for a time. In a word, it is a powerful *carminative;* but it is little given for this purpose, because unpleasant to the taste and often disagreeable in its remote effects, and because we have abundance of other volatile oils, equally powerful, without either of these drawbacks. (See *Caryophyllum*, page 272.)

Turpentine passes into the bowel, and may be found even in the colon (which may, however, *excrete* it also, as will be described). Here it acts reflexly as a **stimulant to the muscular coat**, causing contraction, expulsion of gas and fæces, and recovery of tone if this have been lost by tympanitic distension; and is also a disinfectant and vascular stimulant. In larger doses these effects proceed to purgation. It is therefore given, either by the mouth or as the Enema, in tympanites, especially when this is associated with constipation; and it has proved useful in some forms of diarrhœa and dysentery. It may also be advantageously added to enemata after some forms of hæmorrhage, being, as will be seen, hæmostatic.

Turpentine proves to be an **anthelmintic**, and is given either by the mouth, for the tape-worm, in doses of ʒij to ℥ss (with Castor Oil), which sometimes cause unpleasant symptoms; or as the Enema, for the thread-worm, an excellent method.

Another local application of Oil of Turpentine is to the respiratory organs, as an inhalation. The diluted vapour in steam should be used, or the pure vapour inhaled from a warm sponge, which may, however, prove irritant. Turpentine enters the blood thus, but the chief action desired is a purely local one, to disinfect and stimulate the chronically inflamed or ulcerated surfaces of the lungs and bronchi, and to correct the odour and irritant properties of the products. It is used in gangrene of the lung, dilated bronchi, and allied conditions. Patients suffering from these diseases are also benefited by the air of pine forests, *e.g.* at Bournemouth and Arcachon. Terebene, whether internally or in an inhalation (made like Vapor Pini Sylvestris, page 384), is valuable in phthisis and chronic bronchitis.

2. ACTION ON THE BLOOD.

Oil of Turpentine is freely absorbed by all surfaces, and enters the blood as such. Thus introduced, it produces none of the rapidly fatal effects which follow its injection into the veins of animals, and which are referable in part to coagulation. Probably, however, even in medicinal quantities, Turpentine is partially oxydised at the expense of the blood.

3. SPECIFIC ACTION AND USES.

Found unchanged in the tissues and organs, Oil of Turpentine sets up a series of symptoms, mainly depressant in their character, which follow the reflex stimulant effects already described as referable to its action on the nerves and vessels of the stomach. A full dose produces languor, debility, nausea, dulness, sleepiness, and unsteady gait; a large dose may lead to coma. These **sedative effects on the cerebral and spinal centres** may account for the success of the empirical use of Turpentine in painful affections, such as neuralgia, obstinate sciatica, and hepatic colic.

At the same time the heart is disturbed by the Oil, and the blood pressure decidedly falls. Here we may find the explanation, in part, of the unquestionable value of Turpentine as a **hæmostatic**. Of all the means of arresting internal hæmorrhage, it frequently proves to be the most powerful: bleeding from the lungs, stomach, bowels, and uterus will often cease after a full dose of Turpentine, when every other drug has failed. It is specially useful in intestinal hæmorrhage from typhoid ulceration. In such cases the Oil must be fearlessly exhibited, since life is at stake, a dose of ʒj being followed every two hours by doses of 20 to 30 min.

The temperature is believed to be lowered by Turpentine.

This substance is also a physiological **antidote to phosphorus**, and may be used (best in the form of the crude oil) either to prevent chronic phosphorus poisoning in workmen, or in small repeated doses in acute poisoning, after Sulphate of Copper. See *Cuprum*, page 75.

4. REMOTE LOCAL ACTION AND USES.

Oil of Turpentine, like volatile oils in general, is excreted mainly as such, by the cutaneous and mammary glands, by the lungs and respiratory passages, by the kidneys, and possibly by the liver, biliary mucosa, and intestines. All these organs are influenced by the Oil as it passes through them. Perspiration is slightly increased, and an eruption may appear on the skin. In the bronchial walls it acts as a vascular stimulant, and disinfects both these and their products; it might therefore be a valuable drug in chronic bronchitis, dilated bronchi, and gangrene of the lungs. Its effects as it passes through the kidneys account for the comparatively little use that is made of Turpentine in these and other diseases. Even in moderate doses it may produce symptoms of **irritation and congestion of the urinary organs**, including lumbar pain, repeated painful ineffectual attempts at micturition, a sense of heat and spasm in the perinæum, and frequently hæmaturia. Whilst large doses may cause complete suppression, small doses cause diuresis; and it may therefore be occasionally used with caution in Bright's disease and even in hæmaturia. Part of the Turpentine is excreted as a fragrant violet-smelling body, and this and the unchanged portion exert a remote local effect as stimulants and disinfectants in the bladder and urethra, so that cystitis and gleet have been treated with the Oil.

In passing through the biliary passages, Turpentine or its products are believed to prevent or dissolve gall stones. Its excretion by the colon probably contributes to its effect in expelling gas and fæces.

Terebinthina Canadensis. — CANADA TURPENTINE OR BALSAM. The turpentine obtained by puncturing or incising the bark of the trunk and branches of Pinus balsamea. From Canada.

Characters.—A pale yellow and faintly greenish transparent oleo-resin, of the consistence of thin honey, with a peculiar agreeable odour, and a slightly bitter, feebly acrid, taste; by exposure drying very slowly into a transparent adhesive varnish; solidifying when mixed with $\frac{1}{6}$ its weight of Magnesia.

Composition.—Canada Turpentine has the ordinary composition of turpentines. *See* Oleum Terebinthinæ, page 377.

Dose, 20 to 30 gr.

Terebinthina Canadensis is contained in Charta Epispastica and Collodium Flexile.

ACTION AND USES.

Canada Turpentine is chiefly used for its physical properties. Internally it produces the effects of Oil of Turpentine.

Laricis Cortex.—LARCH BARK. The bark of Pinus Larix, the Common Larch. Collected in Spring; deprived of its outer rough portion, and dried.

Characters.—In flattish pieces or quills. Outer surface dark-red or rosy, somewhat uneven; inner surface nearly smooth, yellowish-white or pinkish-red according to its age. Fracture close, but liber somewhat fibrous; fractured surfaces, except internally, deep carmine. Odour balsamic, terebinthinous; taste astringent. *Substance resembling Larch Bark:* Red Cinchona Bark, known by bitter taste.

Composition.—Larch Bark yields a form of crude *turpentine; tannic acid;* and *larixinic acid*, $C_{10}H_{10}O_5$, a bitter.

Preparation.

Tinctura Laricis.—1 in 8 of Spirit. *Dose*, 20 to 30 min.

ACTION AND USES.

Larch resembles turpentine in its action, but is more pleasant. It is used (but rarely) in the same class of cases.

Thus Americanum.—COMMON FRANKINCENSE. The concrete turpentine, scraped off the trunks of Pinus Tæda, the Frankincense Pine, and Pinus australis, the Swamp Pine. From the southern states of North America.

Characters.—A softish, yellow, opaque solid when fresh, resinous but tough, having the odour of crude American turpentine. Dry and brittle when kept, darker, of milder odour.

Composition.—Frankincense has the composition of ordinary crude turpentines.

Thus Americanum is contained in Emplastrum Picis.

ACTION AND USES.

Frankincense has the same action and uses as resin and its allies just described.

Pix Burgundica.—BURGUNDY PITCH. The resinous exudation from the stem of Pinus Picea (Abies excelsa), the Spruce Fir, melted and strained. From Germany.

Characters.—Hard and brittle, yet gradually taking the form of the vessel in which it is kept; opaque; generally dull reddish-brown; fracture conchoidal; odour agreeable, aromatic; taste sweet, aromatic, not bitter. *Impurity.*—A mixture of common Resin, oil, and water; not completely soluble in glacial acetic acid.

Composition.—Burgundy Pitch consists of various *resinous acids,* with *volatile oil,* as in ordinary crude Resin.

Preparation.

Emplastrum Picis.—26; Common Frankincense, 13; Resin, 4½; Yellow Wax, 4½; Expressed Oil of Nutmeg, 1; Olive Oil, 2; Water, 2.

Pix Burgundica is also contained in Emplastrum Ferri.

ACTION AND USES.

Burgundy Pitch has a **mildly stimulant** action on the skin, and is used only for making plasters.

Pix Liquida.— Tar. A bituminous liquid obtained from the wood of Pinus sylvestris and other species of Pinus by destructive distillation.

Characters.—Semiliquid, brownish-black, of a well-known peculiar aromatic odour. Water agitated with it acquires a pale-brown colour, empyreumatic taste, and acid reaction.

Composition.—Tar is a variable mixture of *creasote, phenol* (carbolic acid), *toluol, xylol, acetic acid, turpentine,* and *resinoid bodies.* *Dose,* 20 to 60 min. in pill.

Preparation.

Unguentum Picis Liquidæ.—5; Yellow Wax, 2.

ACTION AND USES.

Tar, being a compound of Creasote, Carbolic Acid, and other substances, possesses an action very similar to the first two of these bodies, to which the student is referred. Its exact composition being variable, the action of Tar is uncertain; and internally it is now but little employed.

Externally, it is more valuable than either of its important constituents, as a **vascular stimulant and tissue alterative** in dry skin diseases, such as chronic eczema and psoriasis; and as a **nervous sedative** in pruritus.

Internally, Tar may be given in pills, in capsules, or as tar-water (made by shaking up a pint of Tar with half-a-gallon of water, and decanting after settlement), a very popular panacea a hundred years ago. Tar may still be used as a **remote disinfectant and deodorant** in foul discharges from the bronchi and lungs, by which it is probably in part excreted.

Oleum Pini Sylvestris.—Fir-Wool Oil. The oil distilled from the fresh leaves of Pinus sylvestris.

Characters.—Nearly colourless; odour aromatic, lavender-like; flavour pungent, not unpleasant. Sp. gr. not below 0·870. *Solubility*, 1 in 7 of Spirit.

Preparation.

Vapor Olei Pini Sylvestris.—40 min., rubbed with 20 gr. of Light Carbonate of Magnesium, and Water to 1 fl.oz. *Dose for one inhalation*, 1 fl.dr., with ½ pint of cold and ½ pint of boiling water.

ACTION AND USES.

The action of this substance is similar to that of Oil of Turpentine and Larch, but its odour is more agreeable. It is specially useful in the form of the Inhalation, as a mild **stimulant, antispasmodic, and disinfectant,** in some forms of laryngeal disease.

Juniperi Oleum.—Oil of Juniper. The oil distilled in Britain from the full-grown unripe green fruit of Juniperus communis.

Characters.—Colourless or pale greenish-yellow, of characteristic odour and warm aromatic taste.

Composition.—Oil of Juniper contains a hydrocarbon $C_{10}H_{16}$, yielding a white crystalline hydrous compound $C_{10}H_{16},H_2O$, and a polymeric hydrocarbon $C_{20}H_{32}$. *Dose*, 1 to 4 min.

Preparation.

Spiritus Juniperi.—1 to 49 of Spirit. *Dose*, 30 to 60 min.
Spiritus Juniperi is contained in Mistura Creasoti.

ACTION AND USES.

The physiological action of Juniper naturally resembles closely that of Turpentine, but its remote local stimulant action on the kidney is peculiarly marked, whilst this drug is neither disagreeable nor dangerously powerful like the other. Thus it acts as a **stomachic, stimulant, and anti spasmodic**; is absorbed into the blood; is excreted in the urine, to which it imparts an odour of violets; is a **diuretic,** being possibly a specific stimulant of the renal cells, increasing both solids and water; and in large doses causes strangury and renal inflammation.

Juniper is used almost entirely as a diuretic in dropsy not dependent on acute renal disease, *i.e.* in cardiac and hepatic dropsy, and in some cases of chronic Bright's disease. It is best given combined with saline diuretics, or in the form of "Hollands" or Gin.

Sabinæ Cacumina.—SAVIN TOPS. The fresh and dried tops of Juniperus Sabina. Collected in spring, from plants cultivated in Britain.

Characters.—Twigs densely covered with minute imbricated adpressed green leaves, with a large oval depressed central gland on their back. Odour strong, peculiar; taste acrid, bitter, disagreeable.

Composition.—Savin contains the official *volatile oil.*

Dose in powder.—4 to 10 gr.

Preparations.

1. **Tinctura Sabinæ.**—1 of *dried* Tops in 8 of *Proof* Spirit. *Dose,* 20 to 60 min.
2. **Unguentum Sabinæ.**—*Fresh* Tops, 8; Yellow Wax, 3; Lard, 16.

From Sabinæ Cacumina is made :

Oleum Sabinæ.—Distilled in Britain from *fresh* Savin. Colourless or pale yellow, limpid, with an unpleasant odour and bitter acrid taste. Contains several hydrocarbons. *Dose,* 1 to 4 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The action of Savin closely resembles that of Oil of Turpentine, but it is more **irritant, causing vesication** of the unbroken skin, and a profuse flow of pus from a wounded surface. It is occasionally used to promote the discharge from blisters. It dispels venereal warts and condylomata.

Internally.—Savin is a powerful gastro-intestinal irritant, to be avoided or used only with great caution.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION AND USES.

Oil of Savin is absorbed, carried through the organs, and excreted like Oil of Turpentine. It thus acts as a remote local

irritant to the kidneys and mucous membranes, especially those of the genital tract, causing hyperæmia of the ovaries and uterus, increased menstrual activity, and contraction of the pregnant uterus. It is used as an **emmenagogue**, but requires the exercise of great care. More frequently it has been given as an ecbolic for criminal purposes, and has then often caused fatal gastro-enteritis.

ZINGIBERACEÆ.

Zingiber.—Ginger. The scraped and dried rhizome of Zingiber officinale. From the Tropics.

Characters.—Flattish, irregularly-branched pieces, 3 to 4 inches long; a depressed scar at the summit of each branch. Externally pale buff, striated, fibrous; fracture ready, mealy, short, fibrous. Odour agreeable, aromatic. Taste strong, pungent. *Substance resembling Ginger:* Turmeric, which is yellow.

Composition.—Ginger contains an *aromatic volatile oil*, a complex mixture of hydrocarbons and their oxydation products. *Dose*, 10 to 20 gr.

Preparations

1. **Tinctura Zingiberis.**—1 in 8 of Spirit. *Dose*, 15 to 60 min.
2. **Tinctura Zingiberis Fortior.**—"Essence of Ginger." 1 in 2 of Spirit. *Dose,* 5 to 20 min.

From the latter is prepared:

Syrupus Zingiberis.—1 of Stronger Tincture to 25 of Syrup. *Dose,* 1 fl.dr.

Ginger and the Stronger Tincture are also contained in preparations of many important drugs.

ACTION AND USES.

Ginger acts and is used like other substances containing **aromatic** volatile oils. It is one of the most generally employed of **carminatives.**

Curcuma.—Turmeric. The dried rhizome of Curcuma longa. *Appendix* B.P.

Composition.—Turmeric contains two yellow colouring matters, aresin and an acid; a volatile oil; and starch.

Preparations.

Turmeric Tincture.—1 in 6 of *Proof* Spirit.
Turmeric Paper. Made from the Tincture.

USE.

Turmeric Paper is used pharmaceutically as a test for alkalies, which change the yellow to a reddish-brown. As a condiment it is a constituent of curry powder.

Cardamomi Semina.—CARDAMOMS. The dried ripe seeds of the Malabar Cardamom, Elettaria Cardamomum. When the seeds are required for use the pericarps are rejected.

Characters.—About $\frac{1}{6}$ of an inch long, irregularly angular, transversely wrinkled, reddish-brown externally, whitish within; odour and taste agreeably warm and aromatic. Pericarps $\frac{2}{5}$ to 1 inch long; $\frac{1}{5}$ to $\frac{2}{5}$ of an inch broad; ovoid, obtusely triangular, shortly beaked, rounded at the base; brownish-yellow; longitudinally striated; without taste or odour.

Composition.—The active principle of Cardamoms is a *volatile oil*, containing a terpene, $C_{10}H_{16}$, and a camphor.

Preparation.

Tinctura Cardamomi Composita.—$\frac{1}{4}$ oz.; Caraway, $\frac{1}{4}$ oz.; Raisins, 2 oz.; Cinnamon, $\frac{1}{2}$ oz.; Cochineal, 55 gr.; *Proof* Spirit, 1 pint. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

Cardamoms are also contained in Extractum Colocynthidis Compositum, Pulvis Cinnamomi Compositus, Pulvis Cretæ Aromaticus, Tinctura Gentianæ Composita, Tinctura Rhei, and Vinum Aloes; *Tinctura Cardamomi Composita in* Decoctum Aloes Compositum, Mistura Ferri Aromatica, Mistura Sennæ Composita, and Tinctura Chloroformi Composita.

ACTION AND USES.

Cardamoms serve as a highly agreeable, slightly stimulant, flavouring and carminative agent, allied to the peppers.

IRIDACEÆ.

Crocus.—SAFFRON. The dried stigmas and top of the style of Crocus sativus. From Spain, etc.

Characters.—Thread-like orange red stigmas, united below to the top of the yellow style. Odour powerful, aromatic. Taste bitter, aromatic. Rubbed on the wet finger it leaves an intense orange-yellow tint. *Impurities.* — Marigold and safflower petals, chalk, etc. Oil; when pressed between folds of white filtering paper it should leave no oily stain.

Composition.—Saffron contains *polychroite*, an orange-red glucoside, which yields a red colouring matter, *crocin;* also a *volatile oil*, $C_{10}H_{16}$.

Preparation.

Tinctura Croci.—1 in 20. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

Crocus is used only to **colour official preparations.**

Iris.—BLUE FLAG. (*Not official.*) The rhizome and rootlets of Iris versicolor.

Characters.—Rhizome 2 to 4 inches long; jointed; terminated by a scar; annulated from the leaf-sheaths; grey-brown. Rootlets, long, simple. Odour slight; taste acrid, nauseous.

Composition.—A substance, *iridin*, has been obtained from the root, of doubtful constitution. *Dose*, ½ to 2 gr.

Non-official Preparations.

Extractum Iridis (U. S. P.).—*Dose*, 1 to 5 gr. **Extractum Iridis Fluidum** (U. S. P.).—*Dose*, 5 to 60 min. **Iridin.**—A powdered extractive; dark-brown; bitter, nauseous, acrid. *Dose*, 1 to 5 gr.

ACTION AND USES.

Iridin is a powerful **hepatic stimulant or direct cholagogue, and cathartic**; possibly also diuretic. It is a useful purgative in disorders of the liver and duodenum.

SMILACEÆ.

Sarsæ Radix.—JAMAICA SARSAPARILLA. The dried root of Smilax officinalis. Native of Central America; imported from Jamaica.

Characters.—Many feet long; folded and packed into bundles 18 inches long, 4 to 5 inches in diameter, and bound by a long root. Roots furrowed; in thickness not exceeding a goose-quill, greyish to deep reddish-brown; with numerous branched rootlets. Inodorous; taste mucilaginous, feebly bitter and acrid. *Substances resembling Sarsa:* Senega; twisted and keeled. Hemidesmus, cracked transversely. *Impurities.* —Inferior kinds.

Composition.—Sarsaparilla contains a small quantity of a *volatile oil;* a colourless crystalline neutral principle, *smilacin*, closely allied to saponin; *resin*, *starch*, *mucilage*, etc.

Preparations.

1. **Decoctum Sarsæ.**—1 in 8. *Dose*, 2 to 10 fl.oz.
2. **Decoctum Sarsæ Compositum.**—Sarsaparilla, 20; Sassafras, Guaiacum Wood, Liquorice, each 2; Mezereon, 1; Water, 160. *Dose*, 2 to 10 fl.oz.
3. **Extractum Sarsæ Liquidum.**—Spirituous and aqueous with Sugar. 1 in 1. *Dose*, 1 to 4 fl.dr.

ACTION AND USES.

The physiological action of Sarsaparilla is unknown, the diaphoretic and diuretic effects which follow large draughts of its fluid preparations being possibly due to the water alone. It is tolerated in very large doses by the stomach. Smilacin is excreted in the urine.

Great diversity of opinion exists as to the therapeutical value of Sarsaparilla. Whilst the pharmacological evidence is negative, the clinical evidence is discordant, some authorities considering it an **alterative** drug of extraordinary value in syphilis, chronic skin diseases and rheumatism, others as entirely worthless. On the one hand, many cases of these diseases are greatly benefited by general treatment, with rest, good food, baths, and abundance of warm fluids alone; on the other hand, Sarsaparilla is almost always combined with other drugs, including Guaiacum, Sassafras, Mezereon, Iodide of Potassium, and Mercury. If given, it is indicated in old standing cases of syphilis in feeble subjects, who have already suffered from the abuse of Mercury or Iodine, and the Compound Decoction should be freely used.

LILIACEÆ.

Scilla.—SQUILL. The bulb of Urginea Scilla; divested of its dry membranous outer scales, cut into slices, and dried.

Characters.—Slices flattish or four-sided, curved, yellowish, white or pinkish, 1 to 2 inches long, translucent, inodorous, disagreeably bitter; brittle and easily pulverisable if dry, but tough and flexible when moist. *Substance resembling Scilla:* Tragacanth; translucent.

Composition.—Squill has yielded a bitter non-nitrogenous glucoside *scillaïn*, also *scillipicrin* and *scillitoxin*, obscurely related to each other; and much *mucilage*. *Dose,* 1 to 3 gr.

Preparations.

1. **Acetum Scillæ.**—1 in 8 of Diluted Acetic Acid. *Dose,* 15 to 40 min.

   From Acetum Scillæ are prepared:

   a. OXYMEL SCILLÆ.—Acetum Scillæ 5, with 8 of Honey. *Dose,* ½ to 1 fl.dr.

   b. SYRUPUS SCILLÆ.—Acetum Scillæ 1, with 2 of Sugar. *Dose,* ½ to 1 fl.dr.
2. **Pilula Scillæ Composita.**—1¼; Ginger, 1; Ammoniacum, 1; Hard Soap, 1; Treacle, 2. *Dose,* 5 to 10 gr.
3. **Pilula Ipecacuanhæ cum Scillâ.**—1; Compound Powder of Ipecacuanha, 3; Ammoniacum, 1; Treacle, *q.s.* 1 of Opium in 23½. *Dose,* 5 to 10 gr.
4. **Tinctura Scillæ.**—1 in 8 of *Proof* Spirit. *Dose,* 10 to 30 min.

ACTION AND USES.

The action of this important drug so **closely resembles that of digitalis** that it is unnecessary to give it in detail. The student is therefore referred to all that is said respecting Digitalis at page 341, and will apply it to Squill. Briefly, it produces the same increase of vigour and diminution of frequency of the cardiac action; the same contraction of the peripheral vessels and rise of pressure, followed by relaxation commencing in the renal arterioles; and therefore the same kind of diuresis.

Squill is employed in the same class of cases as Digitalis, and frequently in combination with this drug, diuretics being most active when given together. It must not be ordered continuously, but with intermissions, when it is more actively diuretic and less irritant to the stomach and kidneys.

Two properties, however, distinguish Squill from Digitalis, and have to be carefully observed: 1. Squill is much **more irritant to the stomach and intestines even than digitalis,** causing vomiting and purging in full doses, and is very liable to produce dyspepsia even in medicinal quantities; it must thus often be withheld when most clearly indicated. 2. Squill is a **powerful expectorant**. This action is probably a remote local one, the scillaïn stimulating the structures in the bronchial wall during excretion, as it irritates the gastro-intestinal wall during absorption, in this respect resembling Ipecacuanha (emetine) and Senega. It is much employed as a stimulant expectorant in chronic bronchitis, where the indications are to increase the local circulation and secretion, to accelerate the removal of the products, to strengthen the right ventricle, and to promote diuresis. It is contra-indicated in acute bronchitis; and must also be withheld in phthisis, where the stomach and bowels are feeble or deranged. The routine use of Squill for cough of every kind is to be deprecated.

Convallaria.—(*Not official.*) The entire plant of Convallaria majalis, the Lily of the Valley.

Characters.—Leaves radical, usually two, oblong, tapering at both ends, 4 to 6 inches long. Flower-stem leafless, radical, shorter than the leaves. Flowers drooping, bell-shaped, in a loose raceme.

Composition.—Lily of the Valley contains two glucosides, *convallarin*, crystalline, insoluble in water; and *convallamarin*, white, amorphous, bitter, and soluble in water and in spirit.

Non-official Preparations.

Extract of Convallaria.—Aqueous. *Dose*, 2 to 8 gr. **Convallamarin.**—*Dose*, ½ to 2 gr. An Infusion may also be used.

ACTION AND USES.

Convallaria has an action very similar to that of Squill and Digitalis: in medicinal doses it **slows and strengthens the heart, raises the blood pressure, and is a decided diuretic.** It has proved useful in some cases of cardiac dropsy; but it is a very uncertain remedy. Like the two other drugs, it is at the same time a gastro-intestinal irritant, this effect being due to the convallarin, whilst convallamarin acts on the circulation. Aqueous preparations and convallamarin are therefore given.

Aloe Barbadensis.—BARBADOES ALOES. The juice when inspissated, which flows from the transversely cut bases of the leaves of Aloe vulgaris, Barbadoes and Curaçoa Aloes. From the West Indies.

Characters.—Deep reddish-, chocolate-, or dark-brown, or almost black; fracture dull, waxy, sometimes smooth and glassy; opaque in mass, in thin films translucent and orange-brown; powder dull olive-yellow. Odour strong, disagreeable; taste bitter, nauseous. The Curaçoa variety is more glassy and translucent than the Barbadoes, with a distinctive odour. Moistened with spirit, it exhibits microscopically numerous crystals. Almost entirely soluble in proof spirit. *Substances resembling Aloes:* Guaiacum Resin and Resin of Jalap; destitute of bitter taste.

Aloe Socotrina.—SOCOTRINE ALOES. The juice, when inspissated, which flows from the transversely cut bases of the leaves of Aloe Perryi, and probably other species. Imported by way of Bombay and Zanzibar, and known as Socotrine and Zanzibar Aloes.

Characters.—Reddish-brown, darkening by exposure; fracture smooth and resinous, rarely rough and irregular; in thin films transparent, orange-ruby-red or orange-brown; powder bright tawny reddish-brown; odour strong, somewhat agreeable; taste very bitter. Almost entirely soluble in proof spirit. Moistened with spirit and examined microscopically, it exhibits numerous crystals. In other cases it is opaque and liver-coloured, and is then known as *Hepatic Aloes.*

Composition.—Aloes contains: (1) The official *aloin;* (2) *aloe resin,* a brown translucent body, insoluble in water; (3) *gallic acid,* in small quantity; (4) *a volatile oil,* the source of the odour of Aloes; and various less important bodies. *Dose of either kind of Aloes,* 2 to 6 gr.

Preparations.

A. *Of Aloe Barbadensis:*

1. **Aloin.**—Aloin, $C_{16}H_{18}O_7$. A crystalline substance extracted from Aloes by solvents and purified by recrystallisation.

Characters.—Tufts of acicular crystals; yellow; inodorous; having the taste of Aloes. *Solubility:* Sparingly in cold water, more so in cold spirit, freely in hot fluids; not in ether. Not readily altered in acidified or neutral solutions; rapidly altered in alkaline fluids. As obtained from the different varieties of Aloes, the products differ slightly; but they are isomeric in the anhydrous state, and their medicinal properties are similar. *Dose,* $\frac{1}{2}$ to 2 gr.

2. **Enema Aloes.**—40 gr.; Carbonate of Potassium, 15 gr.; Mucilage of Starch, 10 fl.oz. For one enema.
3. **Extractum Aloes Barbadensis.**—Aqueous, $1\frac{1}{4}$ in 1. *Dose,* 1 to 6 gr.

4. **Pilula Aloes Barbadensis.**—Aloes, 2; Hard Soap, 1; Oil of Caraway, $\frac{1}{8}$; Confection of Roses, 1. *Dose*, 5 to 10 gr.
5. **Pilula Aloes et Ferri.**—Aloes, 2; Sulphate of Iron, $1\frac{1}{2}$; Compound powder of Cinnamon, 3; Confection of Roses, 4. *Dose*, 5 to 10 gr.

Barbadoes Aloes is also an important ingredient of: Pilula Cambogiæ Composita (1 in 6), Pilula Colocynthidis Composita (1 in 3), and Pilula Colocynthidis et Hyoscyami (1 in $4\frac{1}{2}$).

B. *Of Aloe Socotrina:*

1. **Aloin.** See page 392.
2. **Enema Aloes.** See page 392.
3. **Extractum Aloes Socotrinæ.**—Aqueous. 2 in 1. *Dose*, 1 to 6 gr.

From Extractum Aloes Socotrinæ is prepared:

Decoctum Aloes Compositum.—Extract, 2; Myrrh, 1; Saffron, 1; Carbonate of Potassium, 1; Extract of Liquorice, 8; Compound Tincture of Cardamoms, 60; Water to make 200. $4\frac{1}{2}$ gr. in 1 fl.oz. *Dose*, $\frac{1}{2}$ to 2 fl.oz.

Extractum Aloes Socotrinæ is also an ingredient of Extractum Colocynthidis Compositum; 1 in $2\frac{1}{4}$ nearly.

4. **Pilula Aloes Socotrinæ.**—2; Soap, 1; Volatile Oil of Nutmeg, $\frac{1}{8}$; Confection of Roses, 1. *Dose*, 5 to 10 gr.
5. **Pilula Aloes et Asafœtidæ.**—Aloes, Asafœtida, Hard Soap, Confection of Roses; of each 1. *Dose*, 5 to 10 gr.
6. **Pilula Aloes et Myrrhæ.**—2; Myrrh, 1; Saffron, $\frac{1}{2}$; Treacle, 1; Glycerine, q.s. *Dose*, 5 to 10 gr.
7. **Tinctura Aloes.**—1; Extract of Liquorice, 3; *Proof* Spirit, 40. *Dose*, 1 to 2 fl.dr.
8. **Vinum Aloes.**—8 fully; Ginger, 1; Cardamoms, 1; Sherry, 240. Nearly 2 gr. in 1 fl.dr. *Dose*, 1 to 2 fl.dr.

Socotrine Aloes is also an ingredient of: Pilula Rhei Composita, 1 in 6; Tinctura Benzoini Composita, 1 in 60.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Aloes acts upon the stomach and intestines as a **bitter and purgative.** The former effect is fully described under *Calumbæ Radix*, page 204. As a purgative, Aloes is peculiar in **acting chiefly upon the colon.** Ten to fifteen hours, or even more, after an ordinary dose (rarely sooner), a soft, formed, or slightly relaxed motion is passed. Very large doses may not act more quickly, but much more violently, with pain, straining, and possibly bleeding from the rectum. Aloes is thus the slowest of all purgatives. The presence of bile is believed to be required to ensure the action of the purgative Aloin, and the drug is, in turn, a stimulant of the biliary flow. The pelvic circulation generally, as well as that of the rectum, is excited by Aloes, which may cause hæmorrhoids and hæmorrhage from the bowel, **increased uterine activity, menstruation**, possibly menorrhagia, and even abortion, if it be given in large doses, to certain subjects, or too frequently.

Aloes is used as one of our most valuable purgatives in suitable cases. It is especially indicated in habitual constipation due to languor of the colon, with atonic dyspepsia and hypochondriacal despondent feelings. It improves instead of deranging digestion, and gains instead of losing in activity by repetition; its laxative effect, too, is of a natural character, if its griping action be covered by carminatives as in most of the official preparations. It must, however, be avoided in irritable states of the rectum, hæmorrhoids, menorrhagia, and pregnancy, unless given with care. Aloes is an ingredient of almost all the compound pills in ordinary use for habitual constipation, those *e.g.* of Rhubarb, Colocynth, and Gamboge; and the Extract is also given with Extract of Belladonna, Nux Vomica, Sulphate of Iron, or Quinine, as a dinner-pill. The Compound Decoction is perhaps the best preparation, being particularly valuable in the constipation of children with hard motions, vermes, indigestion, and derangement of the general health.

The action of Aloes on the pelvic circulation constitutes it a uterine stimulant, and it is given with success as the Aloes and Myrrh Pill in the amenorrhœa of young women, so often associated with chronic constipation and dyspepsia. The Aloes and Iron Pill is probably the most valuable of all remedies in the anæmia, amenorrhœa, and constipation of girls at and after puberty. Enema Aloes is anthelmintic.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION.

Aloin enters the blood and tissues, and is excreted at least in the milk.

MELANTHACEÆ.

Veratri Viridis Rhizoma.—Green Hellebore Rhizome. The dried rhizome and rootlets of Veratrum viride.

Characters.—Entire, sliced, or divided; rootlets attached or not. Entire rhizome 1 to 2 inches or more long, $\frac{3}{4}$ inch or more in diameter; erect, obconical, obtuse at apex; dark brown externally, whitish within. Upper end may bear remains of leaves; and gives off numerous shrivelled yellowish-white long rootlets; or the latter are detached and mixed with it, the rhizome being then scarred. Inodorous; the powder exciting sneezing. Taste bitterish, very acrid. *Substances resembling Veratrum Viride:* Valerian, Serpentary, and Arnica, (q.v.). Veratrum has thicker rootlets and no odour.

Composition.—Veratrum Viride contains a mixture of alkaloids, which have been variously separated and named by different pharmacologists *veratrine*, *veratroidine*, *cevadine*, *cevadilline*, and *jervine*. *Dose of powdered rhizome*, 1 to 3 gr.

Preparation.

Tinctura Veratri Viridis.—1 in 5 of Spirit. *Dose*, 5 to 20 min.

Sabadilla.—CEVADILLA. The dried ripe seeds of Schœnocaulon officinale; sometimes mixed with their pericarps.

Characters.—About $\frac{1}{4}$ inch or less long; narrow, fusiform, prolonged above into a membranous wing; compressed, shining, wrinkled, blackish-brown. Inodorous; powder producing violent sneezing. Taste, bitter, acrid.

Composition.—The chief active constituent of Sabadilla is the official alkaloid *veratrine*, probably associated with other allied bodies, including *cevadine* and *cevadilline.*

From Sabadilla is made:

Veratrina ($C_{37}H_{53}NO_{11}$?).—An alkaloid or mixture of alkaloids obtained from Cevadilla; not quite pure.

Source.—Obtained from Cevadilla by (1) making and concentrating a tincture of the seeds; (2) pouring it into water to precipitate resins, and filtering; (3) precipitating crude Veratrine from the filtrate by NH_4HO, and washing; (4) purifying by solution in HCl, digestion with charcoal, reprecipitation with NH_4HO, filtration, washing, and drying.

Characters.—Pale grey, amorphous; odourless, but very irritant to nostrils; strongly and persistently bitter; very acrid; insoluble in water, soluble in spirit. With H_2SO_4 forms a deep red solution exhibiting a green fluorescence by reflected light. Warmed with HCl, it dissolves, with production of a blood-red colour. *Dose*, $\frac{1}{70}$ to $\frac{1}{16}$ gr. carefully divided in pill.

Preparation.

UNGUENTUM VERATRINÆ.—8 gr. to 1 oz. of Paraffin, with Olive Oil 1 fl.dr.

ACTION AND USES.

1. LOCAL ACTION AND USES.

Externally, the powdered Seeds and Veratrine are **first powerful irritants and then depressants** to the nerves and vessels, causing pricking burning sensations and redness of the skin, followed by loss of sensibility and vesication. Unguentum Veratrinæ is therefore applied to relieve neuralgic and rheumatic pains, but the alkaloid is absorbed by the unbroken skin, and may produce its powerful specific effects.

Inhaled or sniffed into the nose, these substances cause violent sneezing and cough, manifestly by irritation of the nerves. No use is made of this property.

Internally, reflex salivation, dysphagia, epigastric heat and pain, vomiting, and diarrhœa, indicate the irritant effect of these drugs on the alimentary canal.

2. ACTION ON THE BLOOD.

Veratrine enters the blood rapidly from the skin or mucous surfaces. Leucocytes (out of the body) are paralysed or killed by dilute solutions of the alkaloid.

3. SPECIFIC ACTION AND USES, AND REMOTE LOCAL ACTION.

Veratrine may be found in the various organs after administration. Full doses produce, in addition to the painful vomiting of local origin, great muscular prostration, faintness, and finally collapse, preceded and accompanied by a slow, feeble, or irregular pulse, feeble respiration, cold sweats, fall of temperature, occasional muscular twitching and creeping, and itching sensations on the skin. It has now been proved that these phenomena are not referable to the *cerebrum*, which remains unaffected, with perfect consciousness; nor to the motor centres of the *cord*, nor *motor* nerves, all of which are but slightly depressed. **The muscles are the organs attacked by veratrine**, which produces a highly remarkable lengthening of the contraction, the descending portion of the muscle curve (phase of relaxation) being fifty times its ordinary length. Therewith the force of the contraction is increased. These two effects are so marked that the muscle appears to be in a state of tetanus, but the curve is really a single contraction, and not a fusion of closely repeated simple spasms. Larger doses cause weakness of the muscles and finally paralysis.

The heart, after primary acceleration, is affected just like the voluntary muscles, its contractions becoming greatly lengthened, and thus its **frequency reduced** (even by 20 to 60 beats per minute in fever), long pauses occurring at the end of systole. Irregularity, acceleration with feebleness, and finally paralysis, are the result of larger doses. The *blood pressure* rises at first, falls during the stage of infrequency, and is then dangerously lowered. The primary stimulation of the heart and vessels, and part of the succeeding depression, occur through the centres in the medulla. *Respiration* is first accelerated, then slowed, and finally arrested through the centre, the muscles, and the pulmonary vagus; the movements exhibiting expiratory pauses and irregularity. The fall of *temperature*, which may amount to several degrees in fever, appears to be referable to the circulatory failure.

The specific uses of Veratrine depend on its depressing action on the heart, vessels, and body temperature: that is, it is a powerful **antipyretic.** It has been recommended for the same conditions as Aconite, namely, acute febrile processes in strong subjects, such as sthenic pneumonia and acute rheumatism. If it be considered safe and desirable to treat such cases with powerful depressant measures, Veratrine may be used; but in England, at least, the opposite line of treatment is generally followed, and every lowering influence on the heart carefully avoided. In aneurysm and in hæmorrhage, where the blood pressure has to be reduced, Veratrine cautiously given, or the Tinctura Veratri Viridis, may be of service.

Veratrine quickly appears in the urine, being excreted by the kidneys unchanged.

Colchici Cormus.—COLCHICUM CORM. The *fresh* corm of Colchicum autumnale, collected about the end of June; and the same stripped of its coats, sliced transversely, and *dried* at a temperature not exceeding 150° Fahr.

Characters.—*Fresh* corm about 1½ inches long, 1 inch broad, conical, flattened on one side, rounded on the other. Outer coat thin, brown, membranous; inner reddish-yellow. Internally white, solid, yielding a milky juice of a bitter taste and disagreeable odour. *Dried* slices $\frac{1}{10}$ or $\frac{1}{8}$ inch thick, yellowish at circumference, somewhat reniform in outline; surfaces firm, whitish, amylaceous, fracture short; no odour; taste bitter. *Substances somewhat resembling Colchicum:* Tragacanth and Squill, which have different textures, and are not kidney-shaped. *Incompatibles.*—Tincture of Iodine, Guaiacum, and all astringent preparations. *Dose*, 2 to 8 gr. in powder.

Colchici Semina.—COLCHICUM SEEDS. The seeds of Colchicum autumnale, collected when fully ripe, about the end of July, and carefully dried.

Characters.—About $\frac{1}{10}$ inch in diameter, subglobular, pointed at the hilum; reddish-brown; rough, very hard, difficult to powder; no odour; taste bitter, acrid. *Substance resembling Colchicum Seeds:* Black Mustard, which is smaller.

Composition.—Colchicum contains an amorphous, yellowish, bitter alkaloid, *colchicine*, $C_{17}H_{19}NO_5$, readily soluble in water and spirit; tannic and gallic acids, starch, sugar, gum, etc.

Preparations.

A. *Of Colchici Cormus:*

1. **Extractum Colchici.**—25 of *fresh* Corm in 1. A *fresh* Extract. *Dose*, ½ to 2 gr.
2. **Extractum Colchici Aceticum.**—18 of *fresh* Corm in 1. Made like the fresh Extract, Acetic Acid being first added to the crushed corms. *Dose*, ½ to 2 gr.
3. **Vinum Colchici.**—1 of *dried* Corm in 5 of Sherry. *Dose*, 10 to 30 min.

B. *Of Colchici Semina:*

Tinctura Colchici Seminum.—1 in 8 of *Proof* Spirit. *Dose*, 10 to 30 min.

ACTION AND USES.

The physiological action of Colchicum is imperfectly understood, and affords but a partial explanation of its empirical use.

Internally it is a **gastro-intestinal irritant**, acting as an emetic and purgative in full doses, the stools containing a decided increase of bile, partly referable to a **direct cholagogue** effect of the drug. Colchicine appears to enter the blood and tissues, and to act chiefly upon the central nervous system. The convolutions and spinal cord are depressed, large doses causing loss of sensibility and consciousness, and diminishing reflex excitability. The peripheral sensory nerves are also paralysed; the motor nerves and muscles remain unaffected. The respiratory centre is lowered in activity, and death occurs by asphyxia. The heart is weakened, the pulse even becoming intermittent; but this effect is believed to be entirely secondary to the disturbance of the respiration. The kidneys are hyperæmic, and the amount of urine diminished; the uric acid and probably the urea are increased in quantity. The **skin perspires.**

Colchicum is chiefly used **to relieve** the pain and inflammation, and shorten the duration, of **acute gout**, for which purpose it is usually given in doses capable of producing some of the above physiological effects, including an increase of uric acid. It is most successful in first attacks in young robust subjects; less useful, and to be used with caution, in the chronic gout of old or weakly individuals; occasionally it completely fails to afford relief. It is generally prescribed as the Vinum with alkaline purgative salines. In some acute gouty affections of other parts than the joints, such as bronchitis, hepatic congestion, neuralgia, and urethritis, Colchicum occasionally relieves. It is worse than useless in rheumatism. The Extract may be added to purgative pills as a cholagogue.

GRAMINACEÆ.

Farina Tritici.—WHEATEN FLOUR. The grain of Wheat, Triticum sativum, ground and sifted.

Characters.—Familiar.

Composition.—Flour consists chiefly of *gluten* and *starch*, with *gum*, *sugar*, *mucilage*, and *water*.

From Farina Tritici is made:

Mica Panis.—Crumb of Bread.

Mica Panis is contained in Cataplasma Carbonis.

Farina Tritici is also contained in Cataplasma Fermenti.

Amylum.—STARCH. The starch procured from the grains of Wheat, Triticum sativum; Maize, Zea Mays; and Rice, Oryza sativa.

Characters.—White columnar masses or powder; inodorous. Mixed with boiling water and cooled, it gives a deep blue colour with iodine.

Preparations.

1. **Glycerinum Amyli.**—1 to 8 of Glycerine and Water by measure; heated to 240° Fahr. A jelly-like preparation.
2. **Mucilago Amyli.**—1 in 40; triturated in Water, and boiled.

Amylum is also contained in Pulvis Tragacanthæ Compositus; *Glycerinum Amyli in* Suppositoria Acidi

Carbolici cum Sapone, Suppositoria Acidi Tannici cum Sapone, Suppositoria Morphinæ cum Sapone; *Mucilago Amyli in* several Enemata.

ACTION AND USES.

Flour, Bread, and Starch, **nutritive** materials of the first order, are introduced into the Pharmacopœia for pharmaceutical purposes only. *Externally* Starch is **protective and absorbent,** in the form of "dusting powder" for delicate or diseased conditions of the skin. The Glycerinum is an excellent basis for some ointments, and a protective in chapped conditions of the skin. *Internally* the Mucilage is the **vehicle** of all the official Enemata except those of Tobacco and Asafœtida. It is also an **antidote** in poisoning by iodine, but must be followed by an emetic.

Hordeum Decorticatum.—PEARL BARLEY. The dried seed of Hordeum distichon, divested of its integuments. Cultivated in Britain.

Characters.—White, rounded, with a trace of the longitudinal furrow. Taste and odour farinaceous.

Composition.—Barley consists of *starch, gluten, sugar,* etc.

Preparation.

Decoctum Hordei. "Barley Water."—1 boiled in 15 of Water.

ACTION AND USES.

Barley Water is **nutritive and demulcent,** used in catarrh of the throat, and of the respiratory and urinary organs.

Malt Extract. (*Not official.*)—A syrupy yellowish-brown fluid, with a sweet taste; made by acting on malt, or a mixture of malt and flour, by water at a temperature not exceeding 124° Fahr.

Composition.—Malt Extract consists chiefly of *maltose; dextrin; albumens,* including an active ferment *diastase;* and the soluble phosphates of the barley. Good specimens have active diastasic properties, *i.e.* will convert several times their bulk of starch into sugar. *Dose,* 1 to 4 dr.

ACTION AND USES.

Malt Extract is both directly and indirectly nutritive, containing, as it does, not only food elements, but also active diastase, which converts the starch of bread and other farinas into sugar. It is used in wasting diseases. As diastase is most active in alkaline fluids, Malt Extract should be given not less than two hours after a meal, when the acid of the stomach is exhausted; or it may be mixed with warm food a short time before the latter is taken. Maltose is a form of sugar which does not readily give rise to acidity and dyspepsia.

Ergota.—ERGOT. The sclerotium of Claviceps purpurea, produced between the pales, and replacing the grain, of Secale cereale, the Rye.

Characters.—Subcylindrical, tapering, curved; $\frac{1}{3}$ to $1\frac{1}{2}$ inches long; longitudinally furrowed on each side, especially the concave; cracked; violet-purple without, pinkish-white within; fracture short. Odour peculiar, disagreeable, especially if triturated with solution of potash; taste mawkish, rancid.

Composition.—Ergot is believed to contain three important bodies: (1) *Sphacelinic acid*, a non-nitrogenous, resinous-looking, very hygroscopic, unstable body, insoluble in water, soluble in alcohol; its alkaline salts are soluble in water, but readily decomposed; (2) *cornutine*, an alkaloid; and (3) *ergotinic acid*, a glucoside. Besides these there occur in Ergot 30 per cent. of a *fixed oil, colouring matter*, mannite, abundance of potassium salts, and several unimportant alkaloids. *Dose*, 20 to 30 gr.

Preparations.

1. **Extractum Ergotæ Liquidum.**—1 in 1. Aqueous, with Spirit added. *Dose*, 15 to 30 min.

From Extractum Ergotæ Liquidum is made:

Ergotinum.—Ergotin. Purified extract of Ergot; Bonjean's Ergotine. Made by evaporating the Liquid Extract to a syrup, cooling, mixing with Spirit, filtering, and evaporating. *Dose*, 2 to 5 gr.

Preparation.

INJECTIO ERGOTINI HYPODERMICA.—1 to 2 of Camphor Water. Made as required. *Dose*, hypodermically, 3 to 10 min.

2. **Infusum Ergotæ**.—1 in 40. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Ergotæ.**—1 in 4 of *Proof* Spirit. *Dose*, 5 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

In large doses Ergot is a gastro-intestinal irritant, but moderate doses may be given almost indefinitely without disturbing the stomach or bowels. Most of the ergotinic acid is either decomposed in the intestine into an inert substance and glucose, or escapes unabsorbed by the bowel.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

The active principles of Ergot which enter the blood produce no appreciable change on it. Thence they pass into the tissues and organs, and set up well-marked symptoms, if given in full doses for a sufficient time. The parts chiefly affected are the circulation, central nervous system, respiration, intestines, and uterus. **The arteries become distinctly smaller** under Ergot. Pure sphacelinic acid causes powerful contraction, followed in animals by degeneration, of the walls of the arterioles. (Ergotinic acid has a moderately dilating influence on the vessels.) **The blood pressure rises. The heart is reduced in frequency** by Ergot, sometimes twenty to thirty-six beats per minute, and becomes feeble and irregular at last, apparently through the vagus. With respect to the nervous system, the highest centres (cerebral) are not directly influenced by Ergot; possibly the circulation may be disturbed in the brain. **The spinal cord is markedly affected**, a series of nervous phenomena being the result during life, and definite changes found in the posterior (Burdach's) columns after death. The patient first complains of creeping sensations in the limbs, as if an insect were running along the skin; sudden painful cramps or twitchings of the legs follow; the gait becomes staggering (ataxic); and convulsions, with loss of sensibility and motion, may ensue. These spinal effects are chiefly seen in cases of chronic "ergotism," where the drug has been consumed in large quantity in rye bread; they may be met with clinically; and appear to be referable partly to vascular disturbance or disease, partly to a depressing action of ergotinic acid. Cramps and rigidity of the muscles are induced by cornutine. Respiration becomes infrequent after large doses of Ergot; death occurs by asphyxia. The intestine is peculiarly blanched under Ergot, and consequently excited to peristaltic movements. **The uterus** becomes similarly anæmic and **contracts actively**, especially if pregnant, and still more if parturition have commenced, when long and powerful pains are developed. These effects of Ergot on the bowels and womb have also been referred to stimulation of their spinal centres: they are certainly due to the action of the sphacelinic acid and cornutine; not to that of the ergotinic acid. The body temperature falls. Gangrene frequently results from the protracted use of ergotised meal as an article of diet; and it can be rapidly induced by administering sphacelinic acid to animals.

3. SPECIFIC USES.

Ergot is used chiefly to control hæmorrhage and to excite or increase uterine contraction. As a **hæmostatic**, acting apparently by contracting or even closing the arterioles and thus promoting coagulation within them, it is extensively employed in hæmoptysis, hæmatemesis, and menorrhagia, either as the Liquid Extract given by the mouth, or as the Hypodermic Injection of Ergotin.

The use of Ergot in the second stage of labour should be confined to cases of uterine inertia where there is no obstacle in the passages: so frequently is this **ecbolic** abused, that it is calculated more harm than good has resulted from the discovery of its action in parturition. After the completion of the second stage, Ergot may be more safely given to expel the placenta and clots, and ensure contraction of the womb; whilst in *post partum* hæmorrhage it is an invaluable adjuvant to more immediate remedies. In polypus uteri, chronic metritis, subinvolution, etc., Ergot is also used with success.

The action of Ergot on the spinal cord suggests its rational application in paraplegia of inflammatory origin, sclerosis, etc., and instances of recovery under its influence are recorded. It has also been used in chorea, general paralysis, and recurrent mania referable to cerebral hyperæmia.

4. REMOTE LOCAL ACTION AND USES.

Ergot **reduces the amount of the urine, sweat, and milk**, more probably by affecting the local blood pressure and the gland centres in the brain and spinal cord, than by a direct action on the excreting cells. It is a valuable remedy in some cases of polyuria (diabetes insipidus), very rarely in saccharine (true) diabetes. The sweats of phthisis are said to be controlled by Ergot. As an antigalactagogue it is but seldom employed.

5. ACTION AND USES OF THE CONSTITUENTS OF ERGOT.

These have been indicated in the preceding description. Ergotinic acid appears to be useless. Sphacelinic acid promises to become a valuable hæmostatic and ecbolic. The action of cornutine is but imperfectly known.

Saccharum Purificatum.—Refined Sugar. $C_{12}H_{22}O_{11}$.

Characters.—Familiar. *Solubility:* 100 in 45 of water, in 10,000 of spirit. It increases the solubility of lime in water; see *Liquor Calcis Saccharatus*, page 52.

Preparation.

Syrupus.—1 in $1\frac{1}{6}$ of Water, with the aid of heat.

Sugar or Syrup is contained in all Syrups or Lozenges, several Confections, and various Mixtures, Pills, Powders, etc.

ACTION AND USES.

Sugar is **nutritive and demulcent**, but in medicine is chiefly used to cover the taste of other drugs.

Theriaca.—Treacle. The uncrystallised residue of the refining of Sugar.

Characters.—A thick golden syrup; sweet; fermentable.

Theriaca is an ingredient of many pills, and of Tinctura Chloroformi et Morphinæ.

ACTION AND USE.

Treacle is **demulcent, nutritive, and slightly laxative.** It is also employed in pharmacy.

FILICES.

Filix Mas.—Male Fern. The rhizome with the persistent bases of the petioles of Aspidium Filix mas. Collected late in the autumn; divested of its scales, roots, and all dead portions; and carefully dried with a gentle heat. Should not be used if more than a year old.

Characters.—From 3 to 6 or more inches long; the rhizome $\frac{3}{4}$ to 1 inch in diameter, entirely covered by the dark brown bases of the petioles; brown without, yellowish-white or brownish within. Odour feeble, disagreeable; taste sweetish, astringent at first, subsequently bitter, nauseous.

Composition.—Male Fern contains a colourless crystalline body, *filicic acid*, $C_{14}H_{18}O_5$, *fixed* and *volatile oils*, *tannin*, and *resins*. Which of these may be the active principle is uncertain. *Dose of the powder*, 60 to 180 gr.

Preparation.

Extractum Filicis Liquidum.—" Oil of Male Fern." Made by percolating with Ether, and then evaporating or distilling off the Ether. *Dose*, 15 to 30 min.

ACTION AND USES.

Male Fern is an active **anthelmintic**, peculiarly destructive to the tape-worm. It is less irritant to the stomach and bowels than Kousso and Kamala, and should be preceded, and perhaps followed, by a purgative. On the whole, it is the most successful of anthelmintics when properly employed.

LICHENES.

Cetraria.—ICELAND MOSS. The dried lichen, Cetraria islandica.

Characters.—Foliaceous, much branched into lobes; crisp, smooth; brown or greyish-white above, whitish beneath, with small white depressions. Almost odourless when dry; moistened with water, it has a seaweed-like odour. Taste mucilaginous, slightly bitter. A strong decoction gelatinises on cooling.

Composition.—Cetraria contains 10 per cent. of *starch*; 20 per cent. of *lichenin*, $C_6H_{10}O_5$, a starch-like powder, striking a reddish-blue with iodine; and two bitter acids, *cetraric acid*, $H_2C_{34}H_{30}O_{16}$, and *lichesterinic acid*, $C_{14}H_{24}O_3$.

Preparation.

Decoctum Cetrariæ.—1 in 20. *Dose*, 1 to 4 fl.oz.

ACTION AND USES.

Iceland Moss is at once a **bitter tonic and nutritive** substance, but is not in general use.

Litmus.—A blue pigment prepared from various species of Roccella. Used only as a chemical test. Appendix B. P.

Characters.—Small blue lumps, readily reduced to powder.

Preparations.

1. **Solution of Litmus.**—Spirituous and aqueous. 1 in 10.
2. **Blue Litmus Paper.**
3. **Red Litmus Paper.**

FUNGI.

Cerevisiæ Fermentum.—Beer Yeast. The ferment obtained in brewing beer, and produced by Saccharomyces (Torula) cerevisiæ.

Characters.—Viscid, semifluid, frothy, exhibiting under the microscope numerous roundish or oval cells, or filaments composed of cells. Odour peculiar; taste bitter. *Dose*, ½ to 1 oz.

Preparation.

Cataplasma Fermenti.—3, mixed with Water at 100° Fahr. 3; and Flour, 7, added. The mass to be placed near the fire till it rises.

ACTION AND USES.

Yeast Poultice is believed to act as a **sedative and antiseptic**, and was formerly applied to sloughing sores, ulcers, and boils. Its value is very questionable.

Yeast has also been given internally on theoretical grounds in zymotic diseases and in diabetes, apparently without success.

Muscarinæ Nitras. (*Not official.*)—Nitrate of Muscarine, $C_5H_{15}NO_3$, the liquid alkaloid of Agaricus muscarius or Amanita muscaria, the Fly Agaric.

Characters.—A viscid yellowish-brown liquid, soluble in water. *Dose*, $\frac{1}{30}$ to ⅓ gr. hypodermically.

ACTION AND USES.

The action of Muscarine is almost exactly opposed to that of Atropine in every respect, except that it dilates the pupil when applied locally. It also **contracts the pulmonary vessels.** It has been used as an **anhidrotic.**

Agaricus. (*Not official.*)—The Polyporus officinalis, White or Purging Agaric, a fungus growing on the Larch.

Characters. — Yellowish-white, irregular pieces, light, spongy, difficult to powder; odour faint; taste sweetish, acrid, bitter.

Composition. — Agaricus contains *agaric acid*, $C_{16}H_{30}O_5$, H_2O, in shining, inodorous, tasteless crystals; and *resins.* A white crystalline powder called "agaricin" is a variable mixture of these principles.

ACTION AND USES.

Whilst a purgative in large quantities, Agaricus in small doses is a powerful **anhidrotic**, checking also the secretion of the bowels, bronchi, and mammary glands. It has been given with success for the night-sweating of phthisis, either in the form of an Extract or of a Tincture, or as agaricin in doses of $\frac{1}{12}$ to $\frac{1}{6}$ gr. in pill.

GROUP II.

THE ANIMAL KINGDOM.

RUMINANTIA.

Moschus.—MUSK. The dried secretion from the preputial follicles of Moschus moschiferus. From Central Asia.

Characters.—In irregular, reddish-black, rather unctuous grains; odour strong, peculiar, very diffusible; taste bitterish Contained in a roundish or oval sac, about 2 inches in diameter, nearly smooth on one side, covered on the outer side with stiff greyish hairs concentrically arranged around its central orifice.

Composition.—Musk contains an *aromatic principle*, the chemical nature of which is unknown, and a quantity of inactive substances, such as salts, fixed oils, etc. *Dose*, 5 to 10 gr.

ACTION AND USES.

Musk is a powerful **stimulant** of the circulatory and nervous systems, acting probably much like Turpentine and other volatile oils, *i.e.* chiefly reflexly from the nose, mouth, and stomach. It appears to enter the blood and tissues, where it rapidly causes depression so that in full doses its stimulant effect is extremely evanescent. The drug is now but seldom used; chiefly as an antispasmodic in hysteria, laryngismus, hiccup, or as a stimulant in fevers and pneumonia, when other measures have failed, and then not with much success.

Sevum Præparatum.—PREPARED SUET. The internal fat of the abdomen of the sheep, Ovis Aries, purified by melting and straining.

Characters.—White, smooth, almost scentless; fusible at 103°.

Composition.—Suet is composed of *olein* and *stearin.* See *Adeps Præparatus*, page 411.

Suet is contained in Emplastrum Cantharidis and Unguentum Hydrargyri.

ACTION AND USES.

Suet is **emollient**, and used in the above preparations. Internally it is **nutritive**.

Sapo Animalis.—CURD SOAP. Soap made with Soda and a purified animal fat consisting principally of stearin.

Characters.—Light greyish, nearly inodorous, horny when dry, plastic when heated. Soluble in spirit, also in hot water, the solution being neutral or faintly alkaline.

Composition.—The chemical constitution and relations of soaps are described at page 314.

Preparations.

1. **Emplastrum Saponis.**—6; Lead Plaster, 36; Resin, 12.
2. **Emplastrum Saponis Fuscum.**—Brown Soap Plaster. —10; Yellow Wax, 12½; Olive Oil, 20; Oxide of Lead, 15; Vinegar, 160.

Curd Soap is also contained in several other Plasters, Pills, and Suppositories; and in Linimentum Potassii Iodidi cum Sapone.

ACTION AND USES.

These are discussed at page 315.

Lac.—MILK. The fresh milk of the Cow, Bos Taurus.

Milk is used in preparing Mistura Scammonii.

Saccharum Lactis.—SUGAR OF MILK. $C_{11}H_{22}O_{11}$, H_2O. A crystallised sugar, obtained from the whey of Milk by evaporation.

Characters.—Cylindrical masses, 2 inches in diameter, with a cord or stick in the axis; or in fragments of cakes. Greyish-white, crystalline, translucent, hard; scentless, faintly sweet, gritty when chewed. Less soluble in water than cane sugar. *Substance resembling Sugar of Milk:* Acid Tartrate of Potassium; known by taste, and without central cord.

Saccharum Lactis is an ingredient of Pulvis Elaterini Compositus.

ACTION AND USES.

Sugar of Milk is less hygroscopic than Cane Sugar, and is thus more suitable as a vehicle for powders. It is also used to sweeten preparations of milk for artificially fed infants.

Fel Bovinum Purificatum.—PURIFIED OX BILE. The purified gall of the Ox, Bos Taurus.

Source.—Prepared by evaporating fresh Ox Bile to ¼ its bulk; agitating the product with twice its volume of Spirit; separating the sediment of mucus which forms on standing; and evaporating the solution to the consistence of an extract.

Characters. — Yellowish-green; taste partly sweet and partly bitter; soluble in water and in spirit. Gives the colour test for the bile acids. *Impurity.*—Mucus, giving a precipitate with spirit in watery solution.

Composition.—Purified Ox Bile has the composition of fresh bile, less the mucus removed by the spirit. *Dose*, 5 to 10 gr.

ACTION AND USES.

The action of Bile in the duodenum is familiar. When it is admitted into the stomach it is apt to cause vomiting, neutralising the gastric juice, precipitating the pepsin, and being itself rendered inactive. It was introduced into the Pharmacopœia as a bitter and **cholagogue purgative**, but is obviously of doubtful value. It may be used as a basis for aperient pills.

Pepsina.—PEPSIN. A preparation of the mucous lining of the fresh and healthy stomach of the Pig, Sheep, or Calf.

Source.—Made by scraping the cleansed mucous membrane; drying the viscid pulp on a glass surface at 100° Fahr.; and pulverising.

Characters.—A light yellowish-brown powder; odour faint, not disagreeable; taste slightly saline, without indication of putrescence. Very little soluble in water or spirit. Digests a definite weight of albumen with hydrochloric acid. *Dose*, 2 to 5 gr.

ACTION AND USES.

Pepsin is one of the normal constituents of the gastric juice, converting albumen into peptones with the assistance of the hydrochloric acid. The same effect is produced out of the body, or in other cavities such as the rectum.

Pepsin is extensively used as an **aid to digestion**, whether given during or after meals, alone in the solid form, or combined with Hydrochloric Acid; or whether employed to peptonise food before it is taken. It is especially indicated and successful in morbid conditions of the stomach associated with deficiency of the gastric juice, from disease of the follicles, such as atrophy; from excess of mucus, as in the chronic catarrhal dyspepsia of alcoholism, etc.; from deficient blood supply, as in anæmia and general debility; or from irritable states of the stomach with pain and vomiting, such as ulcer and cancer, where the normal stimulation of the mucous membrane must be avoided and fluid food only given. Pepsin is also useful in the dyspepsia of the aged and of infants. It must not be ordered indiscriminately, lest the gastric functions become weaker instead of more active, from want of exercise.

Pepsin is a valuable addition to **nutrient enemata**, the natural digestive power of the secretion of the rectum being comparatively small. Peptonised food is the best form.

Pepsin has also been used as a local application to dissolve the membrane in diphtheria, and even to promote the absorption of tumours.

Liquor Pancreaticus. (*Not official.*) — An aqueous and spirituous extract of the fresh pancreas of the Pig.

ACTION AND USES.

Preparations of the Pancreas are active digestives of proteids and amyloids, and are used with great success to **peptonise** milk, gruel, and soups before administration in cases of digestive debility. They are not suited for separate internal use.

PACHYDERMATA.

Adeps Præparatus.—PREPARED LARD. The purified fat of the Hog, Sus scrofa.

Characters and tests.—A soft white fatty substance, melting at about 100° Fahr. Has no rancid odour. Dissolves entirely in ether. *Impurities.*—Common salt and starch.

Composition.—Lard consists of 60 per cent. of *olein* and *stearin*, with some *palmitin*. Olein, $C_3H_53C_{18}H_{33}O_2$, is a *fluid* oil, a compound of oleic acid, $C_{18}H_{33}O_2$, and glyceryl, C_3H_5. Palmitin and stearin are *solid* oils, compounds of glyceryl with palmitic acid, $HC_{16}H_{31}O_2$, and stearic acid, $HC_{18}H_{35}O_2$, respectively.

Preparation.

Adeps Benzoatus.—Prepared Lard, 50; Benzoin, 1.

From Benzoated Lard is prepared:

UNGUENTUM SIMPLEX.—3; White Wax, 2; Almond Oil, 3.

Prepared Lard is contained in Emplastrum Cantharidis; *either Prepared or Benzoated Lard in* many ointments.

ACTION AND USES.

Lard is a simple **emollient**, forming the basis of many of the official ointments. Benzoated Lard does not become rancid like the other, which for the same reason is now in a measure replaced by Paraffin.

CETACEA.

Cetaceum.—SPERMACETI. A concrete fatty substance, obtained, mixed with oil, from the head of the

Sperm Whale, Physeter macrocephalus, inhabiting the Pacific and Indian Oceans. It is separated from the oil by filtration and pressure, and purified.

Characters.—Crystalline, pearly white, glistening, translucent, with little taste or odour; powdered by addition of a little spirit. Scarcely unctuous to the touch; melts at 111° to 122° Fahr. *Soluble* in ether, chloroform, or boiling spirit; not in water. *Substance resembling Spermaceti:* White Wax, known by general appearance and hardness.

Composition. — Spermaceti is a fat, *cetin*, $C_{16}H_{33}C_{16}H_{31}O_2$, containing not glyceryl but *cetylic alcohol*, $C_{16}H_{33}OH$, in combination with *palmitic acid*, $HC_{16}H_{31}O_2$.

Preparation.

Unguentum Cetacei.—5; White Wax, 2; Benzoin, $\frac{1}{2}$; Almond Oil, 20.

Cetaceum is used in preparing Charta Epispastica.

USE.

Spermaceti is an emollient, and is also employed for pharmaceutical purposes.

AVES.

Ovi Albumen.—EGG ALBUMEN. The liquid white of the egg of Gallus Banckiva, *var.* domesticus.

Composition.—White of Egg contains 12·5 per cent. of *albumen*, with a little *fat*, *sugar*, inorganic *salts*, and 86 per cent. of *water*.

From Ovi Albumen is made: SOLUTION OF ALBUMEN.—*Appendix, B.P.* One White to 4 oz. of Water. Used in testing.

ACTION AND USES.

White of Egg is **demulcent and nutritive**, of value in irritability of the stomach. It is also a valuable **antidote** in poisoning by corrosives and irritants, especially perchloride of mercury, sulphate of copper, lead, and nitrate of silver.

Ovi Vitellus.—YOLK OF EGG. The yolk of the egg of Gallus Banckiva, *var.* domesticus.

Composition.—Yolk of Egg contains only 3 per cent. of *albumen*, and a modification of it called *vitellin* (not precipitated by lead or copper); 14 per cent. of *casein;* 30 per cent. of *fatty bodies*, containing phosphorus and colouring matter soluble in ether; *salts;* and 52 per cent. of *water*.

Ovi Vitellus is an important ingredient of MISTURA SPIRITUS VINI GALLICI, Egg Flip. *See* page 152.

ACTION AND USES.

Yolk of Egg is highly **nutritive**. Egg Flip is a valuable food and stimulant in conditions of extreme exhaustion.

PISCES.

Isinglass.—The swimming bladder or sound of various species of Acipenser, prepared, and cut into fine shreds. Appendix B.P.

Characters.—Light, coriaceous, whitish or yellowish, semi-transparent, inodorous, tasteless; insoluble in cold, soluble in 24 of boiling water, a transparent jelly forming on cooling.

From Isinglass is made: SOLUTION OF ISINGLASS, 1 in 30.

ACTION AND USES.

Isinglass is **nutritive**. It is also **used in chemical testing.**

Oleum Morrhuæ.—COD-LIVER OIL. The oil extracted from the fresh liver of the cod, Gadus Morrhua, by a heat not exceeding 180° Fahr.

Characters and test.—Pale yellow; odour slight, fishy; taste bland, fishy. A drop of H_2SO_4 added to a few drops of the oil on porcelain, develops a violet colour, soon passing to a yellowish or brownish-red. *Impurities.*—Inferior oils.

Composition.—Cod-liver Oil consists chiefly of olein and margarin (see *Adeps*, page 411), with about 5 per cent. of *free* fatty acids (oleic, palmitic, stearic); traces of iodine, bromine, trimethylamin, and the ordinary inorganic salts of animal tissues and products. Some authorities give bile as a constituent; others deny this entirely, the biliary constituents being mainly insoluble in oil. *Dose*, 1 to 8 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action and uses of oils *externally* have been discussed under the head of *Oleum Olivæ*, page 314. Cod-liver Oil is sometimes rubbed into the skin of wasting children as a nutritive, and with perfect success; but it imparts an objectionable colour and odour to the body.

Internally, with a little perseverance, it is as easily taken as other oils; and it is more easily digested, from the amount of free acid contained in it, which greatly facilitates saponification and emulsion as well as absorption.

2. ACTION ON THE BLOOD.

The fatty principles enter the circulation, carrying with them traces of the other constituents. Increasing the richness of the chyle, the Oil improves the quality of the blood, especially as regards the corpuscles, and is thus a **hæmatinic.**

3. SPECIFIC ACTION AND USES.

Passing into the cells, Cod-liver Oil is a nutritive of the first importance, whilst the traces of iodine, bromine, phosphates, and other salts doubtless produce a slight specific action when the oil is given continuously for months. The latter effects are, however, quite secondary to those of the oil proper, that is to its effects as **a food.** Fats and fatty acids appear not only to be oxydised in the tissues, but to spare the metabolism of the nitrogenous elements. Cod-liver Oil differs from other oils (Olive and Almond Oils, cream, butter, etc.), chiefly, but not solely, in respect of the ease with which it is digested and absorbed.

Cod-liver Oil is very extensively used in almost all kinds of chronic disease attended by wasting. The chief of these diseases are scrofula in its various forms, phthisis, chronic bronchitis, rickets, tertiary syphilis, chronic rheumatism, and general debility referable to misery, over-work, and underfeeding. In convalescence from acute illness it is of much service. It is also one of the best restoratives of the nervous functions, and of great value as a **nervine tonic** in neuralgia, headache, mental irritability, despondency, and other less definite disorders, referable to exhaustion or inherent debility of the nervous centres.

In every instance where Cod-liver Oil is indicated, the first point to be determined is whether it can be taken and digested. Besides the difficulty of taste, other conditions contra-indicate the exhibition of the Oil, namely, diarrhœa, hæmoptysis, and considerable fever. Gastric dyspepsia also suggests hesitation in the use of Oil; but if alkaline stomachics are given before meals, and the Oil after, it will be found to agree perfectly in most cases. If Oil be persistently rejected, it should be stopped for a time, and again cautiously tried, or given with Ether (10 minims of Pure Ether to 1 dr. of Oil), with an aromatic oil, with Creasote, or as an emulsion.

HYMENOPTERA.

Mel.—HONEY. A saccharine secretion deposited in the honeycomb, by Apis mellifica, the Hive Bee.

Characters.—When recently separated from the honeycomb, it is a viscid translucent yellowish or brownish liquid, gradually becoming partially crystalline and opaque. Odour peculiar; taste very sweet, characteristic. *Impurities.*—Starch, etc.

Composition.—Honey is a complex mixture of several kinds of *sugar*, *i.e.* cane sugar, grape sugar, and lævulose or inverted sugar (derived by fermentation from the cane sugar); wax, pollen, colouring and odorous matters, etc.

Preparation.

Mel Depuratum.—Made by melting and straining.

From Mel Depuratum is prepared:

OXYMEL.—8; Acetic Acid, 1; Water, 1. *Dose*, 1 to 2 fl.dr.

Honey is also contained in Mel Boracis; Oxymel Scillæ; and Confectiones Piperis, Scammonii, and Terebinthinæ.

ACTION AND USES.

Honey increases the secretions of the mouth and throat, and thus acts as a **demulcent**, relieving dryness, pain, cough, and dysphagia. It is a popular ingredient of gargles, linctuses, and cough mixtures, but to be useful must be properly employed, as the Oxymel, or in combination with Lemon, which has a somewhat similar action on the mouth and pharynx. Honey is also **laxative and nutritive.**

Cera Flava.—YELLOW WAX. Prepared from the honeycomb of the Hive Bee, Apis mellifica.

Characters.—Firm; yellowish; fracture granular; odour agreeable, honey-like. Not unctuous to the touch. Yields nothing to cold spirit; entirely soluble in oil of turpentine.

Impurities.—Starch; paraffins, melting under 146°; resin, soluble in cold spirit; soaps, etc.

Composition.—Wax differs from ordinary fats in containing, as its base, not glyceryl, but another alcohol, *melissic alcohol*, $C_{30}H_{61}OH$, united with *cerotic acid*, $C_{26}H_{53}COOH$.

From Cera Flava is made:

Cera Alba.—White Wax. Made by bleaching Yellow Wax by exposure to moisture, air and light. Hard, nearly white, translucent.

Preparations.

Yellow or White Wax is used in preparing many Plasters and Ointments, Charta Epispastica, and Pilula Phosphori.

USE.

Wax is used only for pharmaceutical purposes. If given internally, it passes out in the fæces entirely unabsorbed.

HEMIPTERA.

Coccus.—COCHINEAL. The dried female insect, Coccus Cacti. Reared in Mexico and Teneriffe, on Opuntia cochinillifera and on other species of Opuntia.

Characters.—Ovate, concavo-convex, about $\frac{1}{5}$ inch long, transversely wrinkled, purplish-black or -grey; yields, when crushed, a puce powder. *Impurities.*—May be "faced" with various white or black powders to improve its appearance; these yield excess of ash. *Resembles* Kino, which is astringent.

Composition.—Cochineal contains a red colouring principle, *carmine* or *carminic acid*, $C_{14}H_{14}O_8$, brownish purple, amorphous, readily soluble in water and spirit.

Preparation.

Tinctura Cocci.—1 in 8 of *Proof* Spirit. *Dose*, $\frac{1}{2}$ to $1\frac{1}{2}$ fl.dr.

Coccus is also an ingredient of Tinctura Cardamomi Composita, and Tinctura Cinchonæ Composita.

USE.

Cochineal is used as a colouring material only.

COLEOPTERA.

Cantharis.—CANTHARIDES. The Beetle, Cantharis vesicatoria; dried. Collected chiefly in Hungary.

Characters.—From ¾ to 1 inch long, ¼ inch broad; with two long wing-sheaths of a shining coppery-green colour, under which are two brownish membranous transparent wings. Odour strong, disagreeable. Powder greyish-brown, containing shining green particles.

Composition.—Cantharis contains ·4 to 1 per cent. of *cantharidin*, a greenish *volatile oil*, and peculiar *fatty bodies*. Cantharidin, $C_{10}H_{12}O_4$, probably an acid, is obtained as shining colourless plates; volatile; soluble in ether, acetic ether, glacial acetic acid, chloroform, alcohol, and oils; and is the active principle, being a most powerful irritant. Some of the other properties of Cantharides may be referable to the oil

Preparations.

1. **Acetum Cantharidis.**—1; Glacial Acetic Acid, 1; Acetic Acid, 9.
2. **Charta Epispastica.**—1; White Wax, 4; Spermaceti, 1½; Olive Oil, 2; Resin, ¾; Canada Balsam, ¼; Water, 6. Mixed and spread on paper.
3. **Emplastrum Cantharidis.**—4; Yellow Wax, 2½; Suet, 2½; Resin, 1; Lard, 2. 1 in 3.
4. **Emplastrum Calefaciens.**—1; Expressed Oil of Nutmeg, 1; Yellow Wax, 1; Resin, 1; Soap Plaster, 8; Resin Plaster, 13; Boiling Water, 5. 1 in 24.
5. **Liquor Epispasticus.**—5; Acetic Ether, 20.

   From Liquor Epispasticus is prepared:

   COLLODIUM VESICANS.—Pyroxylin, 1; dissolved in Blistering Fluid, 20.
6. **Tinctura Cantharidis.**—1 in 80 of *Proof* Spirit. *Dose*, 5 to 20 min.
7. **Unguentum Cantharidis.**—1; Yellow Wax, 1; Olive Oil, 6.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Cantharis is a **rubefacient and vesicant** when applied to the skin, acting upon the nerves and vessels of the part like Mustard and other measures of the same class, as described under *Sinapis*, to which the student is referred (page

227). Its effects differ from those of Mustard chiefly in being much less rapid, but of a more severe degree. The Emplastrum or the Charta has to be applied for a few hours before a sense of smarting, heat, and burning is felt in the part; small vesicles then form, and at the end of eight to twelve hours have united into a single large bulla. The removal of the Cantharis after six hours, and the application of a Linseed poultice, will "raise the blister" more effectually and pleasantly. Vesication is decidedly more rapid after the application of the Acetum, Liquor Epispasticus, or Collodium Vesicans. When the blister has been developed, it is carefully incised, and the raw surface is then encouraged either to heal by simple dressing, or to discharge by the application of an irritant ointment, such as Unguentum Sabinæ. Cantharis is the vesicant in ordinary use for purposes of counter-irritation. Blisters are chiefly employed to control hyperæmia and the inflammatory process; to promote the absorption of morbid products; to relieve pain; and to arrest spasm and other reflex symptoms. The principle upon which they are believed to act is discussed under *Counter-irritants* (page 564). Cantharides is most frequently used in cerebral hyperæmia, being applied to the nape; in acute pleurisy, pericarditis, peritonitis, and meningitis, sometimes in the first stage, especially if pain be severe, but more frequently in the third stage, to promote absorption of effusions and exudations; in subacute or chronic inflammation of the viscera, such as pneumonia, when resolution is slow, or the disease threatens to become chronic; and in subacute or chronic inflammation of peripheral parts, such as the conjunctiva, joints, bones, etc. Neuralgia, if distinctly local in origin and due to congestion or inflammation of the nerves, is sometimes completely relieved by Cantharides blisters; and the pains of acute rheumatism are undoubtedly dispelled by the same means, which are further believed by some physicians to cut short the whole rheumatic process. A blister on the epigastrium is a highly successful mode of treatment in some forms of gastric pain and vomiting.

In every instance Cantharis should be cautiously applied to children, to persons suffering from kidney disease, and to the aged and infirm. The back must not be blistered in bedridden persons, lest bed-sores be produced. Blisters must never be forgotten nor left too long on the skin, otherwise ulceration may be set up, as well as the remote local effects of the drug to be presently described.

Internally.—Cantharis is an irritant to the mouth, throat, and stomach, and must be given well diluted and in small doses of the Tincture only.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

Cantharidin enters the blood both from blistered surfaces and from the stomach, and finds its way into all the organs, to which it clings rather tenaciously. In large doses it disturbs the heart, respiration, and nervous system, producing a rapid pulse, headache, sensory disorders, mental confusion, and finally death by asphyxia. Repeated small doses may cause disease of the capillaries, and set up changes in the solid viscera somewhat similar to those in chronic phosphorus poisoning.

3. REMOTE LOCAL ACTION AND USES.

Cantharidin is slowly excreted by the kidneys, appearing in the urine, which conveys it to the bladder and genital organs. Here it sets up a second set of local effects, similar to those of its immediate action. Small doses cause a sense of heat in the perinæum, itching of the meatus, frequent desire to micturate, and some **diuresis.** Larger doses set up acute general parenchymatous nephritis, with all its characteristic symptoms, including scanty bloody urine, or even suppression; the penis becomes swollen; and painful erections occur, so that the drug has been described as an aphrodisiac. In women, the uterus may become congested and menstruation brought on.

In certain cases of kidney disease Cantharis proves a useful diuretic, and it is given in some genito-urinary disorders, including spermatorrhœa; but it is too dangerous to be generally used internally. For the same reason care must be taken to prevent the absorption of cantharidin by the skin.

ANNELIDA.

Hirudo.—THE LEECH. 1, Sanguisuga medicinalis, the Speckled Leech; and 2, Sanguisuga officinalis, the Green Leech. Collected chiefly on the Continent.

Characters.—Body soft, 2 or more inches long, tapering to each end, plano-convex, wrinkled transversely; back olive-green, with six rusty-red longitudinal stripes. 1, belly greenish-yellow, spotted with black; 2, belly olive-green, not spotted.

ACTION AND USES.

The Leech is employed to **abstract blood,** each Leech removing, directly and by subsequent hæmorrhage, an average of half an ounce of blood. The effect of leeching is depletive; to some extent counter-irritant. It is employed in a variety of congestive or inflammatory affections, superficial and visceral, as well as in cardiac distension and distress. *See* page 507.

SYNOPSIS OF VEGETABLE AND ANIMAL PRODUCTS CONTAINED IN THE BRITISH PHARMACOPŒIA.

ROOTS.

Aconitum
Armoracia
Belladonna
Calumba
Gentiana
Glycyrrhiza
Hemidesmus
Ipecacuanha
Krameria
Pareira
Pyrethrum
Rheum
Sarsa
Sassafras
Scammonium
Senega
Sumbul
Taraxacum

RHIZOMES.

Arnica
Cimicifuga
Filix Mas
Gelsemium
Podophyllum
Serpentaria
Valeriana
Veratrum Viride
Zingiber

TUBERCLE.

Jalapa

CORM.

Colchicum

BULB.

Scilla

WOODS.

Guaiacum
Hæmatoxylon
Pterocarpus
Quassia

BARKS.

Canella
Cascarilla
Cinchonæ
Cinnamomum
Cusparia
Granati Radicis Cortex
Larix
Mezereum
Nectandra
Quercus
Rhamnus Frangula
Rhamnus Purshiana

EXCRESCENCE

Galla

TOPS.

Cannabis Indica
Cusso
Sabina
Scoparium

LEAVES.

Aconitum
Belladonna
Buchu
Coca
Conium
Digitalis
Hyoscyamus
Jaborandi
Laurocerasus
Matica
Senna
Tabacum
Uva Ursi

FLOWERS AND BUDS.

Anthemis
Caryophyllum
Crocus
Papaver Rhœas
Rosa Centifolia
Rosa Gallica
Sambucus Nigra
Santonica

FRUITS OR PARTS OF FRUITS.

Anethum
Anisum
Anisum Stellatum
Aurantium
Bela
Capsicum
Carum Carui
Cassiæ Pulpa
Citrus Limonum
Colocynthis
Conium
Coriandrum
Cubeba
Ecballium
Ficus
Fœniculum
Lupulus
Papaver Somniferum
Pimenta
Piper
Prunus
Rosa Canina
Tamarindus
Uvæ

SEEDS.

Amygdalæ
Cardamomum
Colchicum
Hordeum Distichon
Linum
Myristica
Nux Vomica
Physostigma
Sabadilla
Sinapis
Staphisagria
Stramonium
Triticum Sativum

APPENDAGES OF SEEDS OR FRUIT.

Gossypium
Kamala

HERBS.

Lactuca
Lobelia

WHOLE PLANT

Chirata

FUNGI.

Cerivisiæ Fermentum
Ergota

LICHENS.

Cetraria
Litmus

SYNOPSIS OF VEGETABLE AND ANIMAL PRODUCTS CONTAINED IN THE BRITISH PHARMACOPŒIA (*continued*).

JUICES.

Dried:
- Aloe
- Gutta Percha
- Kino
- Manna
- Opium

Fresh:
- Limonis S.
- Mori S.

Sediment from Juice.
- Elaterium

ALKALOIDS.

- Aconitina
- Apomorphina
- Atropina
- Beberina
- Caffeina
- Cinchonidina
- Cinchonina
- Cocaina
- Codeina
- Conina
- Morphina
- Physostigmina
- Pilocarpina
- Quinina
- Strychnina
- Veratrina

NEUTRAL PRINCIPLES.

- Aloin
- Elaterinum
- Salicinum
- Santoninum

ACIDS.

- A. Citricum.
- A. Gallicum.
- A. Lacticum
- A. Meconicum
- A. Oleicum
- A. Salicylicum
- A. Tannicum
- A. Tartaricum

GLUCOSIDES.

- Acid. Tannicum
- Salicinum
- Santoninum

OILS.

Concrete:
- Myristicæ Exp.
- Theobromatis

Fixed:
- Amygdalæ
- Crotonis
- Lini
- Olivæ
- Ricini

Volatile:
- Anethi
- Anisi
- Anthemidis
- Cajuputi
- Carui
- Caryophylli

OILS—*cont.*

Volatile—cont.
- Cinnamomi
- Copaibæ
- Coriandri
- Cubebæ
- Eucalypti
- Juniperi
- Lavandulæ
- Limonis
- Menthæ Piperitæ
- Menthæ Viridis
- Myristicæ
- Pimentæ
- Pini Sylvestris
- Rosmarini
- Rutæ
- Sabinæ
- Santali
- Sinapis
- Terebinthinæ

Stearoptenes:
- Camphora
- Menthol
- Thymol

RESINS.

- Guaiaci R.
- Jalapæ R.
- Mastiche
- Pix Burgundica
- Podophylli R.
- Resina
- Scammoniæ R.

OLEO-RESINS.

- Copaiba
- Cubeba
- Elemi
- Terebinthina Canadensis
- Thus Americanum

BALSAMS.

- Benzoinum
- B. Peruvianum
- Styrax Præparatus
- B. Tolutanum

GUMS.

- Acacia
- Tragacantha

GUM RESINS.

- Ammoniacum
- Asafœtida
- Cambogia
- Galbanum
- Myrrha
- Scammonium

SPECIAL VEGETABLE PRODUCTS.

- Amylum
- Catechu
- Chrysarobinum
- Lupulinum
- Pix Liquida
- Saccharum Pur.
- Theriaca

ANIMALS AND ANIMAL PRODUCTS.

- Adeps
- Cantharis
- Cera Alba
- Cera Flava
- Cetaceum
- Coccus
- Fel Bovinum
- Hirudo
- Lac
- Mel
- Moschus
- Oleum Morrhuæ
- Ovi Albumen
- Ovi Vitellus
- Pepsina
- Saccharum Lactis
- Sevum

CLASSIFIED TABLES OF THE PHARMACEUTICAL PREPARATIONS OF THE BRITISH PHARMACOPŒIA.

Aceta.—Cantharidis, Scillæ.

Aquæ.—Anethi, Anisi, Aurantii Floris, Camphoræ, Carui, Chloroformi, Cinnamomi, Destillata, Fœniculi, Laurocerasi, Menthæ Piperitæ, Menthæ Viridis, Pimentæ, Rosæ, Sambuci.

Cataplasmata.—Carbonis, Conii, Fermenti, Lini, Sinapis, Sodæ Chlorinatæ.

Chartæ.—Epispastica, Sinapis.

Confectiones.—Opii, Piperis, Rosæ Caninæ, Rosæ Gallicæ, Scammonii, Sennæ, Sulphuris, Terebinthinæ.

Decocta.—Aloes Compositum, Cetrariæ, Cinchonæ, Granati Radicis, Hæmatoxyli, Hordei, Papaveris, Pareiræ, Quercûs, Sarsæ, Sarsæ Compositum, Scoparii, Taraxaci.

Emplastra.—Ammoniaci cum Hydrargyro, Belladonnæ, Calefaciens, Cantharidis, Ferri, Galbani, Hydrargyri, Opii, Picis, Plumbi, Plumbi Iodidi, Resinæ, Saponis, Saponis Fuscum.

Enemata.—Aloes, Asafœtidæ, Magnesii Sulphatis, Opii, Terebinthinæ.

Essentiæ.—Anisi, Menthæ Piperitæ.

Extracta:

1. *Acetic Extract.*—Colchici Aceticum.
2. *Alcoholic Extracts.*—Belladonnæ Alcoholicum, Calumbæ, Cannabis Indicæ, Cascaræ Sagradæ, Colocynthidis Compositum, Gelsemii Alcoholicum, Jaborandi, Jalapæ, Lupuli, Nucis Vomicæ, Papaveris, Physostigmatis, Rhamni Frangulæ, Rhei, Stramonii.
3. *Aqueous Extracts.*—Aloes Barbadensis, Aloes Socotrinæ, Anthemidis, Gentianæ, Glycyrrhizæ, Hæmatoxyli, Krameriæ, Opii, Pareiræ, Quassiæ.
4. *Ethereal Extracts.*—Filicis Liquidum, Mezerei Æthereum, Stramonii.
5. *Fresh Extracts.*—Colchici, Taraxaci.
6. *Green Extracts.*—Aconiti, Belladonnæ, Conii, Hyoscyami, Lactucæ.
7. *Liquid Extracts.*—Belæ, Cascaræ Sagradæ, Cimicifugæ, Cinchonæ, Cocæ, Ergotæ, Filicis, Glycyrrhizæ, Opii, Pareiræ, Rhamni Frangulæ, Sarsæ, Taraxaci.

Glycerina.—Acidi Carbolici, Acidi Gallici, Acidi Tannici, Aluminis, Amyli, Boracis, Plumbi Subacetatis, Tragacanthæ.

Infusa.—Anthemidis, Aurantii, Aurantii Compositum, Buchu, Calumbæ, Caryophylli, Cascarillæ, Catechu, Chiratæ, Cinchonæ Acidum, Cuspariæ, Cusso, Digitalis, Ergotæ, Gentianæ

Compositum, Jaborandi, Krameriæ, Lini, Lupuli, Maticæ, Quassiæ, Rhei, Rosæ Acidum, Senegæ, Sennæ, Serpentariæ, Uvæ Ursi, Valerianæ.

Injectiones Hypodermicæ.—Apomorphinæ, Ergotini, Morphinæ.

Lamellæ.—Atropinæ, Cocainæ, Physostigminæ.

Linimenta.—Aconiti, Ammoniæ, Belladonnæ, Calcis, Camphoræ, Camphoræ Compositum, Chloroformi, Crotonis, Hydrargyri, Iodi, Opii, Potassii Iodidi cum Sapone, Saponis, Sinapis Compositum, Terebinthinæ, Terebinthinæ Aceticum.

Liquores.—Acidi Chromici, Ammoniæ, Ammoniæ Fortior, Ammonii Acetatis, Ammonii Acetatis Fortior, Ammonii Citratis, Ammonii Citratis Fortior, Antimonii Chloridi, Arsenicalis, Arsenici Hydrochloricus, Arsenii et Hydrargyri Iodidi, Atropinæ Sulphatis, Bismuthi et Ammonii Citratis, Calcii Chloridi, Calcis, Calcis Chlorinatæ, Calcis Saccharatus, Chlori, Epispasticus, Ferri Acetatis, Ferri Acetatis Fortior, Ferri Dialysatus, Ferri Perchloridi, Ferri Perchloridi Fortior, Ferri Pernitratis, Ferri Persulphatis, Gutta Percha, Hydrargyri Nitratis Acidus, Hydrargyri Perchloridi, Iodi, Lithiæ Effervescens, Magnesii Carbonatis, Magnesii Citratis, Morphinæ Acetatis, Morphinæ Bimeconatis, Morphinæ Hydrochloratis, Plumbi Subacetatis, Plumbi Subacetatis Dilutus, Potassæ, Potassæ Effervescens, Potassii Permanganatis, Sodæ, Sodæ Chlorinatæ, Sodæ Effervescens, Sodii Arseniatis, Sodii Ethylatis, Strychninæ Hydrochloratis, Zinci Chloridi.

Lotiones.—Hydrargyri Flava, Hydrargyri Nigra.

Mella.—Boracis, Depuratum ; Oxymel, Oxymel Scillæ.

Misturæ.—Ammoniaci, Amygdalæ, Creasoti, Cretæ, Ferri Aromatica, Ferri Composita, Guaiaci, Scammonii, Sennæ Composita, Spiritus Vini Gallici.

Mucilagines.—Acaciæ, Amyli, Tragacanthæ.

Olea.—Amygdalæ, Anethi, Anisi, Anthemidis, Cajuputi, Carui, Caryophylli, Cinnamomi, Copaibæ, Coriandri, Crotonis, Cubebæ, Eucalypti, Juniperi, Lavandulæ, Limonis, Lini, Menthæ Piperitæ, Menthæ Viridis, Morrhuæ, Myristicæ, Myristicæ Expressum, Olivæ, Phosphoratum, Pimentæ, Pini Sylvestris, Ricini, Rosmarini, Rutæ, Sabinæ, Santali, Sinapis, Terebinthinæ, Theobromatis

Oleata.—Hydrargyri, Zinci.

Oleo-Resina.—Cubebæ.

Pilulæ.—Aloes Barbadensis, Aloes et Asafœtidæ, Aloes et Ferri, Aloes et Myrrhæ, Aloes Socotrinæ, Asafœtidæ Composita, Cambogiæ Composita, Colocynthidis Composita, Colocynthidis et Hyoscyami, Conii Composita, Ferri Carbonatis, Ferri Iodidi, Hydrargyri, Hydrargyri Subchloridi Composita, Ipecacuanhæ cum Scillâ, Phosphori, Plumbi cum Opio, Rhei Composita, Saponis Composita, Scammonii Composita, Scillæ Composita.

Pulveres.—Amygdalæ Compositus, Antimonialis, Catechu Compositus, Cinnamomi Compositus, Cretæ Aromaticus, Cretæ Aromaticus cum Opio, Elaterini Compositus, Glycyrrhizæ Compositus, Ipecacuanhæ Compositus, Jalapæ Compositus, Kino Compositus, Opii Compositus, Rhei Compositus, Scammonii Compositus, Tragacanthæ Compositus.

Spiritus.—Ætheris, Ætheris Compositus, Ætheris Nitrosi, Ammoniæ Aromaticus, Ammoniæ Fœtidus, Armoraciæ Compositus, Cajuputi, Camphoræ, Chloroformi, Cinnamomi, Juniperi, Lavandulæ, Menthæ Piperitæ, Myristicæ, Rectificatus, Rosmarini, Tenuior, Vini Gallici.

Succi.—Belladonnæ, Conii, Hyoscyami, Scoparii, Taraxaci.

Suppositoria.—Acidi Carbolici cum Sapone, Acidi Tannici, Acidi Tannici cum Sapone, Hydrargyri, Iodoformi, Morphinæ, Morphinæ cum Sapone, Plumbi Composita.

Syrupi.—Simplex ; Aurantii, Aurantii Floris, Chloral, Ferri Iodidi, Ferri Phosphatis, Hemidesmi, Limonis, Mori, Papaveris, Rhei, Rhœados, Rosæ Gallicæ, Scillæ, Sennæ, Tolutanus, Zingiberis.

Tabellæ.—Nitroglycerini.

Tincturæ.—*Those made with Rectified Spirit* are : Aconiti, Arnicæ, Asafœtidæ, Aurantii Recentis, Benzoini Composita, Cannabis Indicæ, Capsici, Chloroformi Composita, Chloroformi et Morphinæ, Cinnamomi, Cubebæ, Ferri Acetatis, Ferri Perchloridi, Iodi, Kino, Laricis, Lavandulæ Composita, Myrrhæ, Nucis Vomicæ, Opii Ammoniata, Podophylli, Pyrethri, Sumbul, Tolutana, Veratri Viridis, Zingiberis, Zingiberis Fortior.

Those made with Proof Spirit are : Aloes, Aurantii, Belladonnæ, Buchu, Calumbæ, Camphoræ Composita, Cantharidis, Cardamomi Composita, Cascarillæ, Catechu, Chiratæ, Cimicifugæ, Cinchonæ, Cinchonæ Composita, Cocci, Colchici Seminum, Conii, Croci, Digitalis, Ergotæ, Gallæ, Gelsemii, Gentianæ Composita, Hyoscyami, Jaborandi, Jalapæ, Krameriæ, Limonis, Lobeliæ, Lupuli, Opii, Quassiæ, Quininæ Ammoniata, Rhei, Sabinæ, Scillæ, Senegæ, Sennæ, Serpentariæ, Stramonii, Valerianæ.

Those made with Aromatic Spirit of Ammonia, or Ammonia, are : Guaiaci Ammoniata, Opii Ammoniata, Quininæ Ammoniata, Valerianæ Ammoniata.

One in which Ether is used : Lobeliæ Ætherea.

One in which Tincture of Orange is used : Quininæ.

Trochisci.—Acidi Benzoici, Acidi Tannici, Bismuthi, Catechu, Ferri Redacti, Ipecacuanhæ, Morphinæ, Morphinæ et Ipecacuanhæ, Opii, Potassii Chloratis, Santonini, Sodii Bicarbonatis.

Unguenta.—Acidi Borici, Acidi Carbolici, Acidi Salicylici, Aconitinæ, Antimonii Tartarati, Atropinæ, Belladonnæ, Calaminæ, Cantharidis, Cetacei, Chrysarobini, Creasoti, Elemi, Eucalypti, Gallæ, Gallæ cum Opio, Glycerini Plumbi Subacetatis, Hydrargyri, Hydrargyri Ammoniati, Hydrargyri Compositum, Hydrargyri Iodidi Rubri, Hydrargyri Nitratis, Hydrargyri Nitratis Dilutum, Hydrargyri Oxidi Rubri, Hydrargyri Subchloridi, Iodi, Iodoformi, Picis Liquidæ, Plumbi Acetatis, Plumbi Carbonatis, Plumbi Iodidi, Potassæ Sulphuratæ, Potassii Iodidi, Resinæ, Sabinæ, Simplex, Staphisagriæ, Sulphuris, Sulphuris Iodidi, Terebinthinæ, Veratrinæ, Zinci, Zinci Oleati.

Vapores.—Acidi Hydrocyanici, Chlori, Coninæ, Creasoti, Iodi, Olei Pini Sylvestris.

Vina.—Aloes, Antimoniale, Aurantii, Colchici, Ferri, Ferri Citratis, Ipecacuanhæ, Opii, Quininæ, Rhei, Xericum.

Part III.

GENERAL THERAPEUTICS.

CHAPTER I.

INTRODUCTION: THE FOUNDATIONS OF RATIONAL TREATMENT.

THE terms THERAPEUTICS and TREATMENT, although they may at first sight appear too simple to call for analysis, are found, on careful consideration, to include four different notions. These we must study individually.

1. **Health.**—The first notion involved in Treatment is a purely *physiological* one, the conception of *health*, or the normal state, from which the organ has departed, and to which it has to be restored. Health is the result of a number of natural influences acting on the individual, namely, the *extrinsic* circumstances around him, and the *intrinsic* conditions which he brought into the world with him. Our organs having reached their present state by a process of evolution under the influence of the various natural forces which surround us, are obedient to these influences; and when a definite change is thus produced upon them, we call it the "physiological action" of the influence. The first point for the therapeutist to appreciate is, that just as the forces which surround us are themselves constantly varying—the various conditions of the temperature, the air, our food, in short our whole environment, being inconstant—so the physiological state of the body is not a constant quantity. We speak of a "normal" state, and call it "health," but the first essential of life and health is power of change, that is, of accommodation to varying circumstances.

2. **Pharmacodynamics: Physiological action.**—The second elementary notion in the expression "treatment" is, that we possess a certain power of interference, a control over the conditions and circumstances of life, and thus a certain control over the health or physiological state of the individual. A very little consideration will enable us to appreciate our power over the forces of nature. Most of the influences we have just considered as normal in their effects, and many that are entirely morbid in character, are within our control. We can alter the food we eat, the air we breathe,

our clothing, our sources of heat; we may admit into our bodies substances which we find in nature—mineral, vegetable, animal, or altogether artificial. On the other hand, we may voluntarily shun or reject such substances, and avoid many influences, whether for good or for bad, around us. To express this control which we have over our organs and functions, through the conditions to which we can voluntarily subject them, we say we *act physiologically upon them* by such and such means, or that such and such a substance has such and such a *physiological action;* and the science that relates to this power which we possess of modifying physiological activity we call *Pharmacodynamics.*

3. **Pathology.**—The conception of *disease* is also included in "treatment." When the conditions which surround us become unusual or extraordinary, they lead to disturbance of the vital processes. If this be moderate, it is still included under the name of "health;" but if considerable, it is called *disorder* or *disease*, and the influence is called a *morbid* influence. It is essentially impossible to draw a line between health and disease, just as it is impossible to divide influences into salutary or physiological, and morbid or pathological. The pulse is accelerated by joy, by wine, by fever; which of these conditions is health, which disease? All that can be said is, that the change from the normal state is frequently so definite that we cannot reasonably call it "health," that we must find another name for it, and call it "disorder;" or if it be more marked, and attended by suffering, "disease."

4. **Recovery.**—Successful treatment necessarily involves a *power of recovery.* The body possesses abundant provisions for preventing disease, and of recovering from its effects. This power of meeting and overcoming morbid influences depends essentially on the great physiological law which we have already noticed, that the activity of the tissues and organs is not fixed and constant, but varies (within certain limits) with the conditions to which it is subjected. The body is abundantly provided with the following means by which this variation of functional activity can be secured:

First, when occasion demands it, the organs can display an *extraordinary amount of force*, as we see in the case of a muscle such as the biceps, or the heart. The organs thus possess a certain amount of *reserve force*, which is frequently called into play as a means of preventing disease. But for this, we should break down in every part of our body as often as we made an extra demand upon it.

Secondly, if this reserve force be constantly called into play by the continuance of some extraordinary cause, the increased activity gives rise to enlargement or hypertrophy of the organ, and what is known as *compensation* is the result. This great natural method of prevention or recovery by *overcoming the cause of disorder* is well seen in heart disease, and in enlargement of one kidney when the other is diseased.

Instead of themselves meeting extraordinary circumstances by extraordinary activity, many organs are provided with *regulating mechanisms*, by which they can throw them off or escape from them, that is, *expel the cause of disorder*. The stomach rejects a heavy or improper meal; the heart can, to some extent, relieve itself of excessive peripheral resistance in systole, through the depressor mechanism; and the body heat is elaborately regulated by various nervous arrangements.

Thirdly, the work of one organ may sometimes be undertaken by another organ, which thus *removes the effects* of the disorder. This is called *vicarious compensation*, and is well seen at work between the kidney and other excretory organs.

Fourthly, nature has various ways of insuring *rest*.

Fifthly, even when disease and anatomical change have actually occurred, the body possesses means of recovery of the nature of *repair*, which is associated with nutritive activity and frequently with the inflammatory process.

These considerations teach us that just as our organs and functions continue normal, like everything else in nature, in obedience to the laws under which they have reached their present form, so, if they have become deranged by unusual influences, they will return to the normal when such abnormal influences have been overcome or removed.

5. **Therapeutics.**—The following are the four foundations of rational therapeutics. (1) Inasmuch as the organs act in obedience to natural forces in and around us; (2) since we possess the power of controlling these forces; (3) since disorder and disease are but the physiological phenomena, or the anatomical results of the disturbing action of ordinary or extraordinary influences; and (4) since the functions of the organs, and, it may be, even their anatomical state will return to the normal, if the influences become normal: it logically follows that therapeutics as a science consists in bending to our will the numerous natural forces which affect the human body, or in counteracting or neutralising their effects by other forces, until, in either case nature returns to the normal. To handle, as it were, the natural influences which surround us in such a manner as to effect this change on the functions of the body, is called *treating the disorders or diseases* of it. It is with this meaning that we shall speak of *rational treatment*.

Now it is evident that treatment may be of many kinds:

1. **Preventive treatment.**—The science and art of preserving health is known as *Hygiene*, which is manifestly founded on an accurate knowledge of physiology. If we thoroughly understood physiology, and had unlimited power over the forces of nature, we might so preserve health that disease would be unknown. Unfortunately, we have neither this knowledge nor this power except in a small measure, and hygiene is correspondingly imperfect; but as far as it goes, hygiene renders therapeutics unnecessary.

Another form of preventive treatment is *prophylaxis*. This is something more than simple hygiene or preservation of health; it recognises the causes of disease at work, and either avoids them or counteracts them by anticipation.

Prophylactic treatment may be either *negative* or *positive*: a man may guard against infection by avoiding certain things, such as water which is poisoned by cholera or typhoid fever; or he may have himself vaccinated to prevent small-pox, take quinia to prevent ague, or drink lemon-juice to prevent scurvy.

2. **Immediate treatment.**—When hygiene and prophylaxis are powerless or cannot be employed, the case comes into the hands of the therapeutist. The organism is disturbed, deranged, or diseased, and now there is an occasion for *therapeutics*, for *remedy*, for *relief*, or for *cure*. All these terms manifestly imply a necessity for interference, that is, the actual presence of derangement from the normal state, and they introduce us to our own proper subject.

a. Removal of the cause.—Having met with a case of disease which we have failed to prevent, we first naturally try to *remove or destroy the cause*, and thus restore the normal state We extract a foreign body from the finger, or a poison or indigestible meal from the stomach; we neutralise an acid by an alkali; we kill parasites. In doing so, we simply follow nature's second method of recovery. Now there are manifestly as many ways of effecting a cure as there are causes of disease. We may alter the food, and then we say the treatment is **dietetic**; we may alter the atmosphere, and then we say the treatment is **climatic**; or we may employ the chemical and other substances contained in the Pharmacopœia, when our treatment will become **medicinal**.

b. Symptomatic treatment.—If we fail to remove the morbid influence, we may attempt to *neutralise or counteract its morbid effects* on the body. Knowing the physiological action of many different measures, we select such as act in an opposite direction to the morbid cause, and employ them to counteract it. As a method of treatment this is manifestly much inferior to the preceding; we are now striking not at the cause of disease, but only at its effects. Still even this limited power may be of the greatest value; sometimes it is all that is required—we may have to treat only the effect that persists after the cause has ceased or been removed, especially in sensitive and vital organs. This kind of treatment is called **symptomatic, palliative**, and under certain circumstances **expectant** (*expectare*, to wait); it is manifestly a copy of the third method of natural recovery.

It is evident that we have before us here an enormous field for research and application. If we can but find a means, whether medicinal or not, which shall counteract each abnormal condition to which the body may be subjected, we may defy disease. But here we are met by certain difficulties. Before we can hope to combat disease in this way, we must know (1) all about disease and its causes, that is, we must have a perfect pathology; and (2) all about the effects of therapeutical agents upon the body, that is, have a complete pharmacodynamics or pharmacology. It is unnecessary to say how far either the one or the other of these is from being a complete science. Another discouraging fact is that there is a *limit* to all hope of a cure, a limit to all treatment, because the morbid influence may have so far anticipated the remedial as to have altered the body structurally. If a limb is lost, we cannot restore it; if the mitral valve is covered with diseased growth, we cannot renovate it. But we are right when we maintain that these organic structural changes, grave or hopeless as they may be, are but the results of the action of some cause with simple beginnings, which we shall yet discover. As our knowledge of pathology advances we are steadily learning, *e.g.* more about the nature and origin of cancer, for which the limb had to be removed; more about the causes of rheumatism, which covered the cardiac valve with unnatural growth. If we ever cure cancer and rheumatism, we shall manifestly do so by influencing the causes or the beginnings of the two diseases: medicines may be expected to affect morbid *processes* rather than *products*, to alter morbid physiology rather than morbid anatomy. We do, however, possess certain means of treating even structural changes of organs, as we shall discover when we come to discuss metabolism.

The student is now in a position to consider the meaning of two terms constantly being employed in therapeutics—namely, **rational treatment** and **empirical treatment.** Treatment is said to be *rational* when it is suggested by all our chemical, physiological, and pathological knowledge. Such treatment must be successful if our observations are correct: it is founded on great natural laws which are known and understood. *Empirical* treatment is founded on experience only, and conforms to no yet known law. It may be, and frequently is, as successful as rational treatment, or sometimes even more so; but whether successful or unsuccessful, we can offer no scientific reason for it. All that we can say is, that experience has proved incontestably that a particular kind of treatment was beneficial in a multitude of instances, and that it will probably be beneficial again. We hope soon to know more about the various remedies that have been successfully employed ; and as we acquire this knowledge, and come to be able to give a reason for their effects, *i.e.* refer them to some great natural law, we shall transfer these remedies from the group headed "empirical," and add them to the group called "rational." Therapeutics will become a perfect science when empiricism has thus without exception given place to rationalism.

Plan of the following chapters.—In approaching the study of the general therapeutics of the different systems of the body, we will adopt the following plan suggested by the preceding considerations: (1) We shall give a brief sketch of the *physiological* relations of the system. (2) We shall consider fully the *pharmacodynamics* of the same, dealing chiefly with the drugs examined in the previous parts of the work, but referring frequently to non-medicinal measures, such as food, air, exercise, and baths. (3) A rapid sketch will be given of some of the *pathological* relations of the system, those being selected which best serve to illustrate the action and uses of remedies, *i.e.* disorders or derangements rather than diseases of the parts. (4) A brief reference will be made to the evidence of *natural recovery* in the particular system, and to the failure of such attempts, *i.e.* the *limits of treatment.* (5) The *rational therapeutics* of the system, founded on the previous four divisions, will complete the account.

CHAPTER II.

DIGESTION.—THE MOUTH.

I. PHYSIOLOGICAL RELATIONS.

THE process of digestion begins with the reception of food, more or less prepared by cooking. During its brief stay in the mouth, the food is triturated and mixed with mucus and saliva, and its starchy constituents are partly converted into sugar.

1. *Food* forms no part of the subject of the present work, and it will be sufficient to remind the student that the chief proximate principles of a proper diet are proteids, amyloids, fat,

salts, and water. The relative proportions of these constituents vary greatly in different kinds of food.

2. The *sensory nerves* of the mouth (the glosso-pharyngeal, and the lingual and other branches of the trigeminus) receive and transmit to the cerebrum and medulla the impressions of taste, as they are commonly called, whether sweet (the pleasant taste referable to amylolytic action), bitter, salt, sour, hot, burning, warm, pungent, acrid, or nauseous; and the many kinds of aromatic flavours, which are chiefly, however, odours. In the medulla the gustatory impressions fall into a special centre, whence they are reflected (1) to the stomach, the functions of which they modify, as we shall see; and (2) to the salivary and mucous glands of the mouth, which they also influence, chiefly through the chorda tympani. Through the same efferent nerve come other impulses: from the cerebrum, as the result of the sight, taste, smell, or even idea of food; from the stomach, conveyed by the vagus; and, doubtless, from many other sensitive parts, especially in the abdomen.

3. The *flow of saliva and mucus* is the result of the nervous impulses which have just been traced, and which stimulate the protoplasm of the epithelial cells and actively dilate the vessels. The saliva is secreted at the commencement of digestion, is intimately mixed with the food, and imparts to the bolus a faintly alkaline reaction which has an important effect on secretion in the stomach.

4. It is well to distinguish from the ordinary secretions of the mouth, the *excretions* which are also thrown out by the glands. Although these are but little appreciated in health, they are familiar as the source of certain unpleasant tastes in the mouth and odours of the breath, after particular kinds of food and drink, and many drugs, such as Mercury and Iodine.

5. The *muscular acts* of mastication and swallowing are guided by the afferent impressions and by the will.

II. PHARMACODYNAMICS.

We come now to inquire, according to the plan which we have sketched, whether we possess any means of influencing the normal functions of the mouth, and if so, how far such powers can be usefully employed.

1. *Food.*—We have absolute control over our food. We can withhold it altogether; we can alter its quantity and its quality as we please. Especially as regards the mouth, we may modify the proportion of amyloids in the diet, affect their condition by cookery, or convert them wholly or partially into sugar before administration. Malt extracts consist chiefly of dextrin and maltose, made from malted grain and flour.

The control which we thus possess over food is the foundation of the vast subject of dietetics.

2. The *sensory apparatus* in the mouth can be variously influenced. The variety of natural tastes and flavours of which we may avail ourselves is endless; artificial products are hardly less numerous. The art of cookery is much concerned with the proper use of these; so is the growth of wines; and the many natural and artificial condiments act chiefly upon the palate, such as mustard, pickles, and sauces. Beyond the culinary art, an immense number of medicinal agents are contained in the materia medica which may be used in therapeutics proper, to act upon the tongue and palate, and thus upon the nervous centres and viscera. These may be arranged as follows: (1) The great group of warm **aromatic** oils, including Cloves, Allspice, Peppermint, Rosemary, Lavender, Nutmeg, and many others, each with its own peculiar flavour; (2) **bitters**, such as Calumba, Quassia, Quinine, etc.; (3) **aromatic bitters**, of which Gentian, Orange, and Cascarilla are examples; (4) the **spirituous** group, including Spirits, Wines, Chloroform, and Ether; (5) **pungent** substances proper, such as Mustard, Horseradish, and Pyrethrum; (6) **sweet** substances, including Sugar, Liquorice, Glycerine, etc.; and (7) **acid or sour** substances, such as the Mineral Acids, Acid Fruits, and Acid Tartrate of Potassium, to which we shall presently return.

The value of aromatics, bitters, and the other stimulants of the nerves of the mouth, lies in the fact that whilst they increase relish or the enjoyment of eating, and thus the appetite and the amount of food consumed, they provide for the digestion of this increased quantity of nourishment by stimulating the secretion of the digestive fluids in the mouth, and, as we shall see in the next chapter, in the stomach also.

The effect of these substances on the palate also affords us means of covering the tastes of nauseous medicines, of which we constantly avail ourselves. On the other hand, we may employ the unpleasant taste or flavour of certain drugs, such as Valerian and Assafœtida, to produce through the afferent nerves a powerful influence on the sensorium which we may sometimes have occasion to employ.

3. *Salivary and mucous glands.*—Substances and measures which increase the flow of saliva are called **sialagogues** (σίαλον, saliva, and ἄγειν, to cause to flow), and include the greater number of the stimulants of the sensory apparatus just classified. Of these the most important sialagogues are unquestionably diluted acids, including the Diluted Mineral Acids,

Carbonic Acid in effervescence, Vegetable Acids and their salts, wines (which are all acid to a degree), and acid fruits and juices, of which Lemon may serve as a type. The familiar effect of acid drinks in relieving thirst cannot, however, be entirely explained by their influence on the nerves of taste. Here the student is introduced to a great physiological law, which we shall frequently have occasion to notice, *that acid substances stimulate alkaline secretions, and alkaline substances stimulate acid secretions.* The action is probably a local one, the acid or alkali, as the case may be, being quickly absorbed, and reaching the protoplasm of the glands direct.

Other drugs act as *specific sialagogues* upon the terminations of the portio dura in the salivary glands, or on the cells themselves. Such are Jaboraudi and its active principle Pilocarpine, Tobacco, Physostigma, Mercury and Iodine, and the indirect emetics Antimony and Ipecacuanha.

Opposed to these measures are the **antisialagogues**, equally at our service, although but rarely employed. Such are *insipid or nauseous* articles of food or medicine, with which may be classed *depressing emotions and other nervous influences;* dilute *alkaline* or soapy substances acting locally, such as Potash, Soda, and Lime; and certain articles of the first importance in the materia medica which act upon the secreting nerves, and may, therefore, be called *specific antisialagogues.* The type of these is Belladonna (Atropine), with Hyoscyamus and Stramonium (Hyoscyamine). Tobacco in excess has the same effect, as well as Opium.

If the natural secretion fail, certain *substitutes* for the mucus may be employed, which are called **demulcents** (*demulcere*, to soothe), as they sheathe the mouth, tongue, and fauces with a protective coating. Such are simple drinks, especially warm water, toast-water, water and milk; mucilaginous preparations, in a fluid or solid form, including barley-water, gruel, and linseed tea; various preparations of gelatine and isinglass; lozenges made with gums; preparations of starch, eggs, honey, figs, and bread; palatable oils; syrups; and ice.

4. The *excretions* of the mouth can also be influenced by means of substances which are thrown out of the system by this channel, such as Iodine, Lead, and Mercury. The therapeutist can hardly be said to avail himself of this means of acting on the mouth, except in the case of Chlorate of Potassium.

5. The *mastication and insalivation* of the food can also be regulated, on the one hand by ensuring time and care in the process of eating, and on the other hand by ordering such a diet as is entirely fluid, or may be thoroughly triturated and exposed to the juices of the mouth.

III. PATHOLOGICAL RELATIONS.

As has been already suggested, the pathological relations of the mouth and the first part of the digestive process, are of less interest in themselves, for our present purpose, than from their bearing upon digestion in the stomach, and the farther progress of the food.

1. We discover in the *food* the chief cause of all digestive disorders, whether it be unsuitable in quality, excessive in quantity, or taken at over frequent or irregular times.

2. Loss of the *sense of taste* is familiar in fever, the result being further arrest of the salivary flow, and interference with relish and appetite, always a serious matter in such cases. In this connection must be mentioned the unfortunate tastes of most drugs, the difficulty of their administration, and the degree to which they interfere with the appetite.

3. Disorders of the *secretions* of the mouth include chiefly disturbances of the quantity of saliva and mucus. The saliva is probably deficient in some cases of long standing indigestion; and it is markedly wanting in acute febrile conditions, causing dryness of the tongue and mouth, thirst, loss of relish as we have just seen, and inability to swallow, the morsel being rolled hopelessly about the mouth. A somewhat similar condition may be induced by depressing emotions, such as fear or grief; or by certain medicinal or dietetic substances, including Belladonna, Opium, and Alcohol. Excessive secretion of saliva and mucus ("salivation") was very frequent in the days when Mercury was regularly administered until the "gums were touched"; and is still occasionally seen from the same cause, as the result chiefly of accident or idiosyncrasy; or as the effect of Iodine or Iodide of Potassium, under similar circumstances. A *reflex* salivary flow of a very interesting kind occurs at the commencement of vomiting, and in some cases of gastro-intestinal disorder, constituting one form of "pyrosis" or "water-brash." In other cases salivation is produced by disease of the nervous centres.

4. Derangements of the *excretions* of the mouth are among the causes of the "bad taste" and unpleasant odour of the breath, connected with digestive derangements; the other principal causes of the same being decomposition in the mouth, or excretion by the respiratory passages. Some drugs already mentioned have the same effect, such as Mercury, Iodine, Bromine, and Lead; and the prevention of this unpleasant action may be a difficult task.

5. Second only to the food itself as a frequent cause of indigestion is the imperfect manner in which the *mechanical*

processes in the mouth are performed, the solids being imperfectly masticated and insufficiently insalivated from hasty or careless eating, or from disease or actual loss of the teeth.

IV. NATURAL RECOVERY.

We have next to enquire, whether natural recovery, as defined by us in the first chapter, ever occurs in connection with the mouth and its functions. Observation places this beyond doubt, in all the classes of disorder to which we have just referred. The sense of taste is restored after fever has gone. The secretions which have been deranged by the same cause, or by Atropine, Mercury, or Jaborandi, return to the normal quantity and quality when the disturbing influence is spent or has been removed. The excretions again become "sweet" when the substance that disordered them has been completely thrown out. The teeth present side by side with decay a process of repair, which frequently counteracts it.

There is, however, a *limit* to recovery in the mouth, as elsewhere. The teeth decay and fall out; and the other tissues may become involved in serious or hopeless disease. Even then, as we shall presently see, rational treatment is not impossible.

V. THERAPEUTICS.

The rational treatment of diseases originating in the mouth is but the scientific application of the knowledge arranged under the previous four heads, respecting its physiology, the forces acting on the mouth which are at our command, the causes and phenomena of its derangements, and the occurrence and limits of natural recovery.

1. The *food* must always receive most careful supervision, not only in cases where it has been bad, improperly taken, or imperfectly masticated, but in every instance of disorder of digestion from whatever cause, in the mouth or other part of the alimentary canal. The details of dietetic treatment must be learned from other works.

2. The disorders of the *sensory apparatus* of the mouth very rarely call for treatment, but we have constant occasion to avail ourselves of our influence over the nerves of taste for the purpose of relieving derangements of the *secretions*. Thus deficiency of saliva, and the distressing thirst and loss of relish which attend it in fever, may be relieved either through the nerves of taste, or more directly by means of acids in the form of drinks, such as water acidulated with the Mineral Acids, Vinegar and water, Carbonic Acid in effervescing drinks, Cream of Tartar, Lemon Juice in various combinations, and acid fruits,

if not otherwise unsafe, including the Tamarind of the pharmacopœia, grapes, and oranges. Failing or instead of these, ice, sips of water, and some of the demulcents already enumerated may be given. When the deficiency of saliva, the dryness of the mouth, and the lack of relish are less urgent but more persistent, as in chronic dyspepsia, we adopt more pleasing means of stimulation. We have recourse to aromatic, bitter, spirituous, and pungent articles. We order food specially flavoured or made otherwise agreeable to the palate by artistic cookery. When the appetite flags after severe illness or in exhaustion from other causes, we recommend the patient to stimulate his palate with a little wholesome wine, which is at once acid, aromatic, and spirituous. We rouse the nerves of taste and the secreting glands by simple or aromatic bitters in acid or alcoholic combinations before or during meals, or pungent and acid condiments, such as mustard, pepper, and pickles.

3. When it is desired to rouse the gustatory and secreting functions of the mouth independently of digestion, *e.g.* in cases of paralysis of the mouth, and in the chronic thirst of Bright's disease and diabetes, such substances as Pyrethrum, Tobacco, and small doses of Pilocarpine are indicated. The dryness of the mouth and throat caused by Atropine or Hyoscyamine may require the suspension of the drug, or Jaborandi may be prescribed with it unless contra-indicated. On the other hand, salivation produced by drugs must be arrested by removal of the cause, such as Mercury, or by the exhibition of Belladonna.

4. The treatment of unpleasant *excretions* from the mouth is rationally carried out by removing their cause, especially disorder of the stomach and bowels; deodorising the breath; or imparting to it an artificial odour.

5. Defects in the *mechanical apparatus* of the mouth, especially the teeth, have, as a rule, advanced beyond the limits of functional treatment. Even then treatment is not only possible, but dental surgery is one of the most rational and successful branches of local therapeutics. Short of this, much can be done by ordering food in a soft or fluid form, and directing that time and care be spent by the patient over the process of masticating, tasting, and insalivating every morsel.

Lastly, a discussion of the action of drugs upon the mouth introduces us naturally to the therapeutics of the next stage of the digestive process—in the stomach. The substances which stimulate the nerves of taste are constantly employed, as we shall see, to produce reflex activity of the gastric functions; and the thorough insalivation with the alkaline juices of the mouth, for which they also provide, may be used as a powerful means of increasing the acid secretion.

SYNOPSIS OF REMEDIES WHICH ACT UPON THE MOUTH.

Bitters.	Aromatics.	Aromatic Bitters.	Sweets.	Acid Substances.	Demulcents.	Sialagogues.	Anti-sialagogue.
Rheum Nectandra and Beberina Aloe Cinchona and its alkaloids Taraxacum Nux Vomica and Strychnina Calumba Quassia	Rosmarinum Mentha Piperita Mentha Viridis Cinnamomum Lavandula Eucalyptus Sambucus Rosæ Zingiber Cardamomum Myristica Caryophyllum Oleum Cajuputi Carui Fœniculum Oleum Anisi Auethum Coriandrum	Cascarilla Authemis Gentiana Chiretta Lupulus Serpentaria Limon Aurantium Canella Cusparia	Glycyrrhiza Glycerinum Saccharum Theriaca Mel Tamarindus Chloroformum	Pot. Tartr. Acida Tamarindus Limon Aurantium Wines Acidum Sulphuricum Dilutum Acidum Nitricum Dilutum Acidum Hydrochloricum Dilutum Acidum Nitro-Hydrochloricum Dilutum Acidum Aceticum Dilutum Acetum Oxymel Acidum Phosphoricum Dilutum Acid Tartaricum Ac. Citricum Ac. Carbonicum	Ficus Ulmus Ovum Hordeum Tamarindus Linum Uvæ Tragacantha Acacia Amygdala Cassia Water Ice Milk Isinglass Cetraria Syrupus Theriaca Mel Amylum Triticum Oleum Olivæ Oleum Amygdalæ	Tabacum Jaborandi Physostigma Acids Potassæ Tartras Acida Tamarindus Limon Aurantium Prunus Wines Hydrargyrum Iodum Antimonium Ipecacuanha	Potassium Sodium Ammonium Calcium Lithium Magnesium Opium Belladonna Hyoscyamus Stramonium Nauseous substances Insipid foods and drinks Tabacum (excess)
	Ammoniacum Assafœtida Serpentaria Valeriana Moschus Sumbul	**Spirituous.** Alcohol (in every form) Æther Chloroformum	**Pungents or Acrid.** Piper (partly aromatic) Cubeba ditto Pyrethrum Capsicum Sinapis Armoracia Guaiacum				

CHAPTER III.

DIGESTION.—THE STOMACH.

I. PHYSIOLOGICAL RELATIONS.

GASTRIC digestion is mainly effected by the gastric juice, an acid secretion which owes its solvent and chemical power to pepsin and hydrochloric acid. The gastric secretion is stimulated by the *mechanical* presence of food; by the *products* of digestion, part of which is rapidly absorbed; by impressions on the *nervous centres,* such as tastes, which were referred to in the previous chapter; and by the presence of saliva and other *dilute alkaline fluids* at the mouths of the tubules. During digestion the gastric vessels actively dilate; the muscles move vigorously; by the end of four hours much of the proteids have become peptones; the sugar, starch, and fats are broken down or emulsified, but remain chemically unaltered; and the whole of the products, constituting the chyme, are transferred to the duodenum.

The nervous arrangement by which the stomach is stimulated, or prepared to receive and digest food, is chiefly a local one; the contact of food, digested products, and dilute alkalies acting on ganglia in the gastric wall itself. Besides this, the stomach is connected with a *centre* in the medulla, and with the cerebrum, by means of afferent and efferent nerves—the vagus and the sympathetic. The impressions which thus reach the sensorium and the gastric centre are reflected as *impulses* to the stomach, through the efferent nerves; which also convey from the cerebrum the impulses generated by sensations of taste, as we saw in the last chapter, as well as by the smell, sight, or idea of food. Besides these, numerous impressions from the intestines, liver, kidneys, and generative organs, indeed from all impressionable parts whatsoever, influence the stomach by being reflected to it through its centre in the medulla. The influence of these nervous impulses upon the stomach is very marked. They affect the secreting glands, the vessels, and the muscles, exciting, arresting, or otherwise modifying, as the case may be, the secretion of gastric juice; and under certain circumstances they give rise to vomiting.

II. PHARMACODYNAMICS.

We have now to inquire how many of the conditions which influence gastric digestion are under our control: how far we can act physiologically on the stomach.

1. We have complete power over all that enters the stomach in the form of *food* and drink, and much influence, as we have seen, over salivary digestion. Even if the food have left the mouth and reached the stomach, we can evacuate its contents by means of the pump, or by the use of emetics, which will be considered in chapter iv.

2. As regards the *gastric juice*, we can increase its flow in many ways. We can irritate the tubules mechanically by the character of the food, making it more or less solid as may be required. We may provide, as the first part of the meal, substances, such as soup, which will be rapidly peptonised and absorbed, and stimulate the follicles to abundant secretion. We can subject the secretion to nervous influences which are at our command, such as the agreeable sensations of taste, which are aroused by artistic cookery, wholesome condiments, and grateful wines, as well as by pleasing associations during meals. The activity of the glands may be increased through the medium of the local circulation by various means to be presently described. Further, we can provide for moderate alkalinity of the contents of the stomach, by increasing the salivary flow. The same end may be secured more certainly by the administration of dilute alkaline solutions before meals, such as Bicarbonate of Soda, Sal-volatile, or Liquor Potassæ, which are amongst the most useful and generally employed of remedies, and constitute the **alkaline stomachics.** We can go even farther than this, and modify the amount either of the pepsin, or of the hydrochloric acid, or of both, by giving them along with the food, and thus constituting them **digestive adjuvants.**

3. The activity of the *nerves* of the stomach is readily influenced in either direction. We may increase their sensibility by administering the same series of hot substances which we studied in the mouth, such as Alcohol, Aromatic Oils, Pepper, and Mustard; the effect being not confined to a sense of warmth in the epigastrium, but extending to stimulation of the local, and even the general circulation, and the associated nervous structures, as we shall presently see. These substances, as well as the aromatic bitters, such as Gentian or Orange, and the simple bitters, such as Calumba, have the effect of stimulating the nerves, dilating the vessels, and possibly increasing the activity of the glands and muscles of the stomach, whilst they create the sensation of hunger, probably by setting up these changes in the gastric wall. They form, therefore, other groups of stomachics, **the aromatic, spirituous, bitter** and **pungent stomachics.** On the contrary, we may appease the sense of hunger by such artificial means as tobacco smoking.

Equally powerful is the influence of many substances and measures, as **gastric sedatives**, in reducing the sensibility of the afferent nerves, and thus interfering with gastric sensations, and the gastric functions which depend upon the reflection of impressions. Opium is thus all-powerful in preventing or relieving pain in the stomach, and in arresting the gastric secretions and movements. Diluted Hydrocyanic Acid and Belladonna and its allies, also act in this way; as well as Carbonic Acid in the form of effervescence; water, either as hot as it can be drunk or in the form of ice; Bismuth, whether mechanically or physiologically is uncertain; and Oxalate of Cerium in a manner which is still quite obscure. A number of drugs remove causes of irritation, and are thus gastric sedatives, such as Oxide of Silver, Creasote, and Carbolic Acid, which arrest disorder of the mucous membrane. Various applications to the epigastrium, including poultices, fomentations, and blisters, afford a convenient means of soothing the gastric nerves reflexly through the nervous centres.

4. The *circulation* in the stomach is also so far under our control, as we have already seen. The many substances which stimulate the nerves also redden the surface of the mucous membrane, by dilating the vessels and increasing the local blood flow within physiological limits, such as Alcohol, Ether, Aromatic and Pungent articles (Pepper, Mustard, Capsicum, etc.), and Bitters. Besides these, there are numerous substances of a more powerfully irritant nature which we note chiefly for the purpose of suggesting caution in their employment for other purposes. Arsenic, Iron, Mercury, and indeed the salts of most of the metals: Senega, Digitalis, and Scilla; Colchicum and Veratrine, are examples of drugs which are specially apt to derange digestion. On the other hand, the local circulation can be rendered less active by means of Acids; salts of Silver, Zinc, Lead, in small doses; Ergot, Opium, Tannic Acid, and the many vegetable astringents containing it, such as Kino, Catechu, and Cinnamon. These are **gastric astringents**, and indirectly, therefore, another class of *gastric sedatives.*

5. The *movements* of the stomach can be readily modified. The energy of the churning movements increases with the acidity of the chyme, and we can take advantage of this knowledge by administering acids after meals, such as Diluted Nitric, Hydrochloric, or Nitrohydrochloric Acids, which are thus another class of *gastric stimulants*, sometimes called **gastric or stomachic tonics.** Specific nervo-muscular stimulants, such as Strychnine, probably act in the same way, as well as the stimulants of the nerves and vessels, especially Ether and Volatile Oils. That peculiar excitation of the movements of

the stomach which is called emesis or vomiting, will be specially described in the next chapter.

Per contra, the gastric movements may be directly diminished by Diluted Hydrocyanic Acid, Opium and Morphine, Carbonic Acid and all effervescing drinks; by the Alkalies, which reduce acidity; as well as indirectly by remedies which soothe the nerves and the vessels, as we have seen.

6. We have already referred to our influence on the *contents* of the stomach—to the food, and to the acidity of the chyme. The reaction may be neutralised or completely changed by Alkalies or Alkaline earths, which are thus **antacids**. Beyond these, Charcoal absorbs the gaseous products of digestion; whilst Sulphurous Acid, Sulphites and Hyposulphites, Carbolic Acid, Creasote, the Aromatic Oils, and possibly all Bitters and Vegetable Astringents in some degree correct decomposition—**gastric disinfectants**. In this connection mention must be made of many **antidotes**, which act upon poisons in the stomach.

7. *Action of carminatives.*—The effects of Aromatic and Pungent Oils, of Alcohol and Ether, in rousing the nerves of the stomach, in increasing the activity of the gastric circulation, in exciting muscular contraction, and in modifying the contents, have been separately described; and we may add that they probably at the same time relax the cardiac orifice. The result is eructation, and relief of gaseous distention, of cramps and pain, the whole being so striking and complete that these substances have been grouped together under the special name of **carminatives** (*carmino*, I soothe). Their effect is, however, more than local. The nervous impressions produced by carminatives spread even beyond the stomach and its sympathetic ganglia to the cord, medulla, and brain, and reflexly to the heart and vessels, and cause general stimulation, both of the bodily and the mental faculties. Carminatives are thus one form of *diffusible stimulants.*

III. PATHOLOGICAL RELATIONS.

Derangement of gastric digestion, or dyspepsia, is probably the most common disorder of the human body, and may be taken to illustrate, in a general way, the rational treatment of diseases of the stomach.

By far the most frequent causes of derangement of the stomach are to be found in the quantity and quality of the food; in its imperfect mastication and insalivation; in deficiency or in excess of fluids, which dilute the gastric juice and check secretion; and in the abuse of alcohol. Certain drugs in common use are also apt to cause indigestion, such as Opium, Arsenic, Iron, Digitalis, and Scilla. Organic disease of the stomach itself necessarily leads to the same result. Excess of the gastric juice is rare. As a rule, the juice is deficient in relation to the amount of food taken, whether from excess of the latter or from absolute diminution in the secretion, for instance, in debility after illness. Again, either the pepsin or the hydrochloric acid may be deficient, or impeded in its special action. Gastric indigestion is occasionally of nervous origin: depressing mental states readily arrest the action of the stomach; and morbid impressions originating in the liver, intestines, kidneys, or uterus, often have the same effect.

Disorder of the muscular functions of the stomach may also cause dyspepsia. Feebleness of the churning movements leads to imperfect exposure of the food to the action of the juice; feebleness of the expulsive efforts delays the removal of the chyme, *excess of which arrests digestion.* In other cases, excessive peristalsis hurries the food into the duodenum before the process of gastric digestion has well commenced.

If from any of these or from other causes, the contact of the food and the gastric juice be deficient, the process of digestion becomes disturbed. The secretion, unable to effect complete conversion of the proteids into peptones, produces some partial chemical change in them; the other constituents of the food are also broken up; and—what with the unnatural products, and, in the case of a heavy meal, the excess of peptones themselves—the process of digestion is completely arrested. A decomposition occurs, associated with the formation of organic acids; the sugar, starch, and fat probably become partially changed; and the contents of the stomach are converted—not into the normal chyme, but into a sour, fermenting mass with abundant development of gas. The stomach becomes distended, and the neighbouring organs impeded in their action, especially the heart. The nerves, vessels, and glands of the stomach are irritated by the products, so that the mucous membrane swells; the rosy hue passes into pallor; and the surface is coated with a tenacious mucus. The gastric and associated centres are powerfully excited; and impulses are sent out which lead to hiccup, eructation, and vomiting. If these do not give relief, the contents pass into the bowel, irritate it also by their excessive acidity, and give rise to duodenal dyspepsia and diarrhœa. Even when the urgent symptoms have subsided, the morbid anatomical condition remains for a time associated with an excessive secretion of mucus; the digestive power is arrested; pain and fulness are felt; and loss of appetite (anorexia) and nausea are complained of. All these symptoms will call for relief by treatment.

In *chronic dyspepsia* the attacks are much less severe, but practically continuous. This may depend on organic disease of the stomach, such as cancer; on nervous disorder; on disease of other organs, *e.g.* the kidney, or of the system generally, such as gout or tuberculosis. The muscular power of the stomach also becomes weak in chronic dyspepsia, the peristaltic movements less vigorous, the organ possibly dilated, and the action of the orifices disordered.

IV. NATURAL RECOVERY.

Acute dyspepsia generally passes off within so many hours or days if left entirely without treatment, vomiting being obviously a natural provision for its relief, and the subsequent nausea or anorexia a means of preventing the introduction of fresh food and affording the stomach temporary rest. These are valuable suggestions for treatment. The duration and degree of suffering in acute indigestion may, however, be considerable; and the violence of the symptoms, such as vomiting, may lead to injury or permanent disease. Therapeutical interference is therefore essential. Organic diseases of the stomach are frequently beyond treatment in themselves, but most of the distressing symptoms by which they are attended, are perfectly capable of relief.

V. THERAPEUTICS.

The conclusion to be drawn from the considerations in the preceding sections is manifestly to the effect that certain disorders and diseases of the stomach are capable of rational treatment.

1. *Prophylactic Treatment.*—Prevention is essentially the proper means of treating dyspepsia. The common causes of disorder, and the opportunity of removing them, are constantly at hand. Prevention here lies almost entirely in the direction of diet, and includes care with respect to the quantity and quality of the food, the frequency and general arrangement of the meals, the circumstances, social and otherwise, under which the food is taken, the thorough performance of digestion in the mouth, the amount of fluids with meals, including alcohol, and other matters which do not call for discussion here. *Dieting is the most important part of the treatment of indigestion:* without attention to it, medicinal treatment is of no avail.

Next to the food, the most ready, but not the most advisable, means of preventing dyspepsia is furnished by the gastric juice itself, or its important constituents, artificially administered. Hydrochloric Acid and Pepsin may be given alone or combined, either during or immediately after meals; or the food may be previously peptonised by the addition to it in the process of cooking, of a digestive extract, made from the mucous membrane of the stomach, or from the pancreas, of the calf or pig.

The therapeutist should endeavour, however, to adopt a much less artificial method of treatment than this. He should try to call into play some of the influences to which the gastric flow is peculiarly sensitive, and thus to increase the natural juice, instead of borrowing its constituents from other sources. First, he will ensure a certain mechanical effect of the food on the stomach, by seeing that "slops" are not indulged in, at the same time remembering that a small quantity of a warm nutritive fluid dish, such as soup, which will be quickly absorbed and stimulate the follicles, is the best commencement of a considerable meal. Drugs will also be prescribed. The most powerful medicinal stimulants of gastric activity must reach the stomach distinctly before meals. Those which increase the activity of the nerves and vessels, and indirectly the activity of the glands and muscles, namely alcoholic, aromatic, bitter and pungent stomachics, are best given in combination, *e.g.* the tinctures of Gentian, Orange, Cascarilla, Chiretta, etc., variously combined with spirits such as Spiritus Ammoniæ Aromaticus, Spiritus Myristicæ, Spiritus Armoraciæ, or Spiritus Chloroformi. A still more powerful gastric stimulant is to be combined with these, viz. an alkaline stomachic, in the form of a preparation of Potassium, Sodium, or Ammonium, the Bicarbonate of Sodium being, for many reasons, the salt most frequently selected. Let it be carefully noted that the alkali must be given with the aromatic bitters, *shortly before meals.* This constitutes the routine medicinal treatment of dyspepsia, and we may repeat that the same result is obtained by successful insalivation of the food, of which the method is but an artificial imitation. The mental occupation and general surroundings of the patient, as well as the times and amount of physical exercise with relation to meals, will also require to be carefully regulated.

2. *Immediate treatment.*—If acute dyspepsia be actually present, it is too late to attempt to stimulate the gastric flow. We must make our choice whether we shall evacuate the stomach, or neutralise the acidity and absorb the gas which are causing the distress. The use of emetics will be described in the next chapter. If the alternative measure be chosen, we give a dose of alkali or an alkaline earth; not, let it be observed, as an alkaline stomachic, but purely as an *antacid to the contents* of the stomach. Bicarbonate of Sodium is again the means commonly chosen for the purpose, combined probably with Carbonate of Ammonium and an aromatic oil, such as Peppermint or Ginger,

or more elegantly with Spiritus Ammoniæ Aromaticus, to act as a carminative. The result is that the acidity of the contents is reduced—and it is remarkable how small may be the quantity of alkali required for this purpose—so that the mass passes with comparative safety into the duodenum. Instead of Soda, Magnesia or its Carbonate is occasionally used as an antacid, which, being also a purgative, hastens the expulsion of the offending contents. Gas may be partly absorbed by charcoal, given in powder or in the form of lozenges or biscuits, and partly removed by eructation induced by the carminative, which will further help to arrest decomposition, relieve pain, and rouse the heart and nervous system from the state of depression caused by the attack.

3. *Treatment of the effects.*—When the process of indigestion is at an end, and prostration requires to be relieved, the therapeutist will avail himself of some of the many gastric sedatives at his disposal, of which Diluted Hydrocyanic Acid, Bismuth, and Morphia (whether given subcutaneously, applied to the epigastrium endermically, or combined in an effervescing mixture) will be found the most useful. Champagne or effervescing Soda-Water and Brandy will serve at once as a gastric sedative and a general stimulant, or Milk with Lime-Water or Soda-Water may be given as a sedative and nutritive. Ice is the best means of relieving thirst; in other cases water as hot as can be drunk often acts as a valuable sedative. Linseed poultices, hot fomentations, or warm compresses may be ordered to the epigastrium, and in severe and persistent cases Mustard or Cantharides blisters. The chief problem will be to support the strength without increasing the pain and sickness, and in very urgent cases the patient must be fed by the rectum.

The greatest caution must be exercised in resuming gastric digestion. The best treatment, unless the patient be very weak, is to rest the stomach absolutely for many hours. Fortunately, anorexia conduces to secure this end. The first food given should be in the smallest possible bulk, and of the blandest and most digestible kind, such as broths, essences, meat juices, and milk; and just before each meal a small dose of a mixed stomachic, such as Bicarbonate of Sodium, with Diluted Hydrocyanic Acid or Bismuth, and a mild aromatic bitter, such as Gentian, should be prescribed, which will restore the secretion of gastric juice and arrest the flow of alkaline mucus set up by the dyspepsia.

4. *Chronic Dyspepsia* is rationally treated on the same principles as the acute form of the disorder, with certain modifications, which a careful consideration of the pathological associations of the particular case and general experience will suggest. The

patient's diet will require constant supervision. The possible causes of indigestion, beyond food, must be searched for, such as disorder of the liver or bowels, of the heart or kidneys, gout or tuberculosis, and the treatment must be arranged accordingly.

The flow of juice may still require stimulating by Alkalies, but these remedies must not be overdone, as they tend to depress the muscular and cardiac energy. The *digestive adjuvants*, Pepsin or Diluted Hydrochloric Acid or both, may now more rationally be brought to the relief of the failing secretion, being given during or at the end of meals. In still more chronic cases, *e.g.* in aged persons, where chronic indigestion depends on wasting of the glandular structures, peptonised foods will be of great service. In most cases of chronic dyspepsia, the nervo-muscular structures of the stomach require to be strengthened, and distension or overfulness of the organ avoided. Flatulent substances must be excluded from the diet, such as green vegetables, sweets, sloppy food, and large draughts of strong, hot tea. Powerful bitters, such as Strychnine and Quinine, the former being peculiarly valuable as a specific nervo-muscular stimulant, and Diluted Nitric and Phosphoric acids—in short, *stomachic tonics*—are given to increase the functional and nutritive vigour of the muscular coat. In some of these cases *gastric disinfectants*, such as Creasote and the Sulphites or Hyposulphites, may be required to cleanse the contents and surface of the organ, and destroy the organisms of putrefactive and fermentive processes.

Chronic dyspeptics always suffer from starvation to a degree, and the food selected for them must be nutritious as well as digestible. Alcohol in proper form and amount may be required, and bland preparations of Iron, such as the Ammonio-citrate, ordered at intervals, if they can be taken without increasing the dyspepsia. If the dyspepsia depend on a chronic catarrh of the stomach with excessive secretion of mucus, *gastric astringents* will manifestly be indicated, such as Oxide of Silver or Zinc, or Kino, Cinnamon, and other substances containing Tannin.

The treatment of *organic disease* of the stomach cannot be discussed here, but it is hoped that the student will understand from what he has learned, the principles which he must follow to fulfil the most urgent indications in this class of cases also: to relieve pain and sickness, and to insure functional rest of the stomach, remembering that many of the symptoms are referable to dyspepsia.

The therapeutics of vomiting, and incidentally of certain other associated disorders of the stomach, will be discussed in the next chapter.

SYNOPSIS OF DRUGS WHICH ACT UPON THE STOMACH, EXCLUDING EMETICS.

ALKALINE STOMACHICS.

Liquor Potassæ.
Potassii Bicarb.
Sodii Bicarb.
Ammonii Carb.
Spiritus Ammon. Aromaticus.
Magnesia.
Magnesia Levis.
Magnesii Carbonas
Magnesii Carbonas Levis

BITTER STOMACHICS.

As in the Mouth

AROMATIC STOMACHICS.

As in the Mouth

AROMATIC-BITTER STOMACHICS.

As in the Mouth

SPIRITUOUS STOMACHICS.

Alcohol (in all forms)
Ether
Chloroform

ACID STOMACHICS.

Acidum Sulphuricum Dilutum
Acidum Hydrochloricum Dilutum
Acidum Nitricum Dilutum
Acidum Nitro-Hydrochloricum Dilutum
Acidum Phosphoricum Dilutum
Acidum Aceticum

PUNGENT STOMACHICS.

Piper
Cubeba
Capsicum
Sinapis
Armoracia

NERVO-MUSCULAR STIMULANTS, OR STOMACHIC TONICS

Mineral Acids
Nux Vomica
Strychnina
Bitter Stomachics
Aromatic Stomachics
Bitter Aromatic Stomachics
Spirituous Stomachics
Pungent Stomachics

STIMULANTS, BECOMING IRRITANTS AND EMETICS.

Iodum
Tabacum (in excess)
Scilla
Digitalis
Veratrina
Colchicum
Senega
Copaiba
Cambogia
Guaiacum
Ferrum
Hydrargyrum
Arsenicum

DIGESTIVE ADJUVANTS

Pepsina
Acidum Hydrochloricum Dilutum

NERVO-MUSCULAR DEPRESSANTS.

Hot Water
Belladonna
Hyoscyamus
Stramonium
Acidum Hydrocyanicum
Opium
Carbonic Acid
Ice
Tabacum (at first)

GASTRIC ASTRINGENTS.

Acid. Tannic.
Argenti Oxidum
Plumbi Acetas
Zinci Oxidum

ANTACIDS.

Potassium
Sodium
Lithium
Ammonium
Calcium
Magnesium

MECHANICAL SEDATIVES.

Bismuthi Carbonas
Bismuthi Subnitras

SEDATIVES OF OBSCURE ACTION.

Cerii Oxalas
Ipecacuanha

GASTRIC DISINFECTANTS.

Carbo
Acid. Tannicum
Creasotum
Acidum Sulphurosum
Sodii Sulphis
Sodii Hyposulphis.

CARMINATIVES.

Camphora
Serpentaria
Asafœtida
Ammoniacum
Valeriana

All Aromatics
Aromatic Bitters
Spirituous Stomachics
Pungent Stomachics

CHAPTER IV.

EMETICS AND VOMITING.

I. PHYSIOLOGICAL RELATIONS.

VOMITING is a complex act, in which the respiratory muscles, the abdominal walls, the walls of the stomach, the sphincter of the cardiac orifice, and the œsophagus and pharynx participate. Occasionally it is to be regarded as a strictly physiological process for removing excess of food from the stomach, as in the regular sickness of infants after a full meal of milk. It is determined and directed by an elaborate nervous mechanism, consisting of a special centre, the *vomiting centre*, in the medulla; of *afferent* nerves from the fauces, stomach, abdominal viscera, and peritoneum, the chief of which are the glosso-pharyngeal, vagus, and sympathetic, and, indeed, from other parts of the body—the sensory nerves generally; and of *efferent* nerves (the vagus, phrenic, and intercostals) to the muscles, cardiac orifice, and certain associated parts to be presently mentioned. Vomiting may be induced by impressions originating in the areæ supplied by any of the afferent nerves; by stimulation of the centre by certain substances which reach it through the blood; or by the downward flow to it of certain mental impressions, such as nauseous tastes, foul smells, disgusting or terrifying sights, and depressing ideas.

With the evacuation of the stomach there occur certain *associated acts* which are of great importance to the therapeutist. A flow of saliva may precede vomiting, as is well seen in some reflex cases. The gall bladder may be forcibly emptied of bile, which regurgitates into the stomach and is vomited. Expiratory movements, such as sneezing and coughing, frequently occur at the beginning of sickness, indicating the spread of the stimulant impressions to the associated respiratory centre in the medulla; and it must be carefully observed that an expiratory effect is also produced by compression of the chest during the evacuation of the contents of the stomach, as well as at the end of the act, when the air is forcibly expelled through the larynx to prevent the entrance of solid particles. Thus vomiting tends to empty the respiratory passages, as well as the upper part of the alimentary canal. The stimulant effect of emetics on the salivary flow is frequently accompanied by a secretion of bronchial mucus; and this being expelled by the upward current of air, tends further to clear the passages.

Whilst the respiratory and gastric centres are thus powerfully stimulated in vomiting, the cardiac and vascular centres are greatly depressed, the action of the heart and the pulse being reduced in force—at least between the acts of sickness, and a sense of faintness and giddiness overspreading the patient from further cerebral anæmia. At the same time, the motor centres in the brain, and probably in the cord, are lowered, leading to prostration and inability to support the weight of the body, and compelling recumbency. Lastly, the centres of perspiration are stimulated, causing the profuse sweating familiar in many cases of sickness. Altogether, the student will appreciate how extensive is the physiological disturbance produced by vomiting, and how great is the influence which it furnishes us over several of the most important functions of the body.

II. PHARMACODYNAMICS.

Vomiting may be excited by certain substances and measures, which are called **emetics.** Emetics are said to be either (1) **direct,** when they act upon the stomach itself; or (2) **indirect,** when they act upon the vomiting centre or some other part of the nervous mechanism. *Direct* emetics are the larger of the two classes. They include *warm* water, Infusion of Chamomile, Salt and Water, Mustard, Carbonate of Ammonium, Sulphate of Zinc, Alum, and Sulphate of Copper. They are necessarily given by the mouth. *Indirect* emetics are a small group of drugs, including only Ipecacuanha, Antimony, and Apomorphine. These excite vomiting by whatever channel they may be admitted into the blood—subcutaneously, by the mouth, or by the rectum. For the same reason they produce greater general depression, that is, depress the other vital centres in the medulla more than moderate doses of the direct emetics. Physical irritation of the fauces is a ready emetic measure of the indirect class; and nauseous drugs, such as castor oil and rhubarb, frequently act on the nerves of the same part, but are not given with this intention. Ipecacuanha and Antimony act on the stomach as well as on the centre, and are really, therefore, **direct and indirect emetics.**

The means at our disposal for *averting or arresting vomiting* are as various as the parts of the extensive mechanism upon which they act. They may be called **anti-emetics.** First of these may be mentioned the measures which *reduce the irritability of the vomiting centre,* such as the recumbent posture, nourishing food, Amyl-Nitrite, Nitro-Glycerine, Alcohol, Opium, Chloral, the Bromides, and Diluted Hydrocyanic Acid. A second class, more readily available, comprise the *sedatives of* *the afferent nerves* from the stomach, such as *Hot* Water, Ice, Diluted Hydrocyanic Acid, Carbonic Acid, Bismuth, Dilute Alkalies, Opium, Ipecacuanha and Calomel in small doses; measures which act *indirectly* upon the stomach and reduce the irritability of its nerves, such as poultices or blisters to the epigastrium; and *sedatives of the afferent nerves to the vomiting centre from other organs*, for instance, demulcents to the throat, poultices to the abdomen, or applications to the os uteri.

III. PATHOLOGICAL RELATIONS.

Vomiting being regarded for our present purpose as a physiological act, it may be considered to be disordered, (1) if *excessive;* and (2) if *defective, insufficient, or absent* when it would be salutary or desirable. We will illustrate each of these conditions.

1. *Excessive vomiting* occurs as the result of disorder or disease of the stomach; morbid conditions of other parts of the abdomen, such as hernia, cough, severe pain, injury or disease of the brain, or disturbance of the circulation and senses, including sea-sickness. The cause of vomiting may be in the centre itself, especially as a consequence of previous violent vomiting, or of urea and certain extrinsic poisons, such as antimony.

2. *Defective vomiting* may be said to occur when only attempts at retching ensue on the presence of direct or indirect stimulation of the centre. In the vast majority of cases, however, we have to deal with conditions in which, whilst vomiting is urgently demanded, no attempt at vomiting is made by nature, the substances which require to be expelled from the stomach being of a non-irritant or even sedative nature, such as narcotic poisons. This introduces us, further, to the use of emetics for other purposes than simple evacuation of the stomach. Vomiting may be desired for the sake of obtaining one or more of the associated effects on other viscera. In certain inflammatory diseases of the larynx and bronchi, such as croup and bronchitis, which are attended by the production of thick or solid products, or whooping cough, which is characterised by defective or disordered expulsive power, an emetic will be indicated to empty the respiratory passages and restore the free entrance of air. Similarly, rigidity of the cervix uteri in the first stage of labour is believed by some obstetricians to call for emetics which shall relax the uterine sphincter.

IV. NATURAL RECOVERY.

Vomiting usually ceases with the removal of its cause, but it may persist indefinitely, until the therapeutist steps in.

Whilst it is in itself a natural provision for relief, there is a limit to its beneficial effect. Protracted vomiting appears to increase the irritability of the mucous membrane and nerves of the stomach, and thus to tend to go from bad to worse; and the same is the case with the vomiting centre, which may become so sensitive as a consequence of sickness that the slightest change of posture brings on the symptom afresh. There is urgent need for treatment in such cases.

V. THERAPEUTICS.

The therapeutical relations of vomiting, rationally considered, are obvious. Excessive vomiting has to be arrested; vomiting may have to be assisted when it is ineffectual, or excited when entirely absent; and the action of emetics may be taken advantage of for other purposes than to empty the stomach.

1. *Excessive Vomiting.*—The study of the physiology and pathology of vomiting serves to impress upon the student the absolute necessity for diagnosis, or investigation of the cause of disorder, before rational therapeutics can be carried out, and the thoroughly unscientific and unsatisfactory character of the practice which applies treatment to symptoms without ascertaining the pathological condition on which they depend. How extremely irrational it would be to attempt to relieve by the same means the vomiting caused by indigestible food at the commencement of acute indigestion, and the vomiting due to the swelling which persists in the second stage. At the former period, vomiting is relieved by temporarily encouraging it by a good emetic; at the second period, the very opposite set of measures—gastric sedatives—must be employed.

The first step to be taken manifestly is to attempt to *remove the originating cause* of the reflex act. If the stomach contain irritant food, it must be quickly neutralised, as we saw in the last chapter; if a poison, some antidote must immediately be administered; or either of the two may be removed from the stomach by facilitating and completing vomiting, or by means of the pump. Once emptied, the stomach must be quieted by the gastric sedatives studied in the last chapter. If the cause be discovered in any of the other abdominal organs, the same plan of removal, if possible, must be pursued. Vomiting originating in injury or disease of the brain will call for the special treatment proper in such cases, and the free use of nervous sedatives, such as the Bromides of Potassium and Ammonium. If the vomiting centre is being irritated by some intrinsic poison such as urea, or an extrinsic poison such as antimony, the excretion of the morbid substance by the kidneys, skin, or bowels, must be hastened, or its effects antagonised by stimulants.

If, on the other hand, disturbance of the circulation in the centre be the cause of the vomiting, we must restore the normal supply of blood by keeping the patient in the recumbent posture and insuring bodily rest, and stimulate the circulation by Alcohol and food, if they can be retained in the stomach. Nitro-glycerine, Nitrite of Amyl, and Chloral appear to have been given with some success under these circumstances.

When the cause cannot be removed we must reduce the irritability of the centre by Opium or similar drugs.

2. *Defective Vomiting: Use of Emetics.*—The adoption of vomiting as a therapeutic measure, and the selection of an emetic from the list just given, are matters of the greatest practical importance. The student must not think that in inducing vomiting we are effecting a simple mechanical act of evacuation; he must appreciate the extent and degree of physiological disturbance which we are setting up. If the patient be very weak, the therapeutist may be alarmed to find that his emetics or unsuccessful attempts at emesis are followed by intense circulatory depression, faintness, and even threatening dissolution. The condition of the patient must be carefully, if quickly, ascertained; and if vomiting be considered a justifiable and proper method of treatment, a selection must be made of one or other emetic, according to the patient's strength and other circumstances. Fortunately, in most cases of acute poisoning, where vomiting is urgently indicated, the patient is able to bear the shock, and Sulphate of Zinc, twenty grains in two ounces water, Sulphate of Copper, two to five grains in an ounce of water, or a table-spoonful of Mustard in a cupful of hot water, should be given without delay. Where blocking of the respiratory passages by the products of croup or bronchitis calls for an emetic, great judgment is required to estimate the patient's strength and to select a proper emetic, if any. Vinum Ipecacuanhæ, in doses of 1 fl.dr. for children, or $\frac{1}{2}$ fl.oz. for adults, is the best, because it is also an expectorant. Antimony is decidedly more depressing, in doses of 1 to 2 gr. of Tartarated Antimony, or $\frac{1}{2}$ fl.oz. of Vinum Antimoniale for an adult. Carbonate of Ammonium is a suitable emetic in these cases, being a stimulant to the heart and respiration. In acute dyspepsia the mildest emetics are indicated, including tepid water, Salt and water, warm nauseous infusions such as Chamomile; and may be freely given. Apomorphia is at once the most certain and generally applicable, whilst the least employed of emetics, because rarely at hand. $\frac{1}{10}$ gr. may be given subcutaneously, or a dose of $\frac{1}{8}$ gr. by the mouth. It is frequently necessary to follow an emetic by a stimulant, such as alcohol.

SYNOPSIS OF REMEDIES WHICH INFLUENCE VOMITING.

EMETICS.			ANTI-EMETICS.	
DIRECT.	INDIRECT.	DIRECT AND INDIRECT.		
Anthemis Sinapis Ammonii Carbonas Alumen Cupri Sulphas Zinci Sulphas Sodii Chloridum Tepid Water	Apomorphina.	Antimonium Tartaratum Ipecacuanha	Acting through the centre.	Opium Ammonii Bromidum Potassii Bromidum Chloral Hydras Alcohol Food Amyl Nitris Nitro-Glycerinum Acidum Hydrocyanicum Dilutum
			Acting through the gastric nerves.	Hot Water Acidum Hydrocyanicum Dilutum Carbonic Acid Bismuthum Dilute Alkalies Opium Ipecacuanha (in small doses)
				Calomel (in small doses)

CHAPTER V.

DIGESTION—THE DUODENUM.

WE are now in a position to follow the process of digestion in the duodenum. The other functions of the intestine will be considered in the next chapter.

I. PHYSIOLOGICAL RELATIONS.

The chyme passes out of the stomach with an acid reaction, and its undigested constituents are at once subjected to a second process of digestion in the duodenum by an *alkaline* fluid, which is a mixture of the pancreatic juice, the bile, and the enteric juice. The pancreatic juice converts the remaining starch into sugars, and the remaining proteids into peptones, leucin, tyrosin, and fatty acids; whilst in association with the bile it partly emulsifies and partly saponifies the fats. The sugars are converted into lactic acid and butyric acid, possibly in part by the succus entericus, which is also amylolytic. These products of duodenal digestion, as well as those of gastric digestion, are absorbed into the portal and lymphatic systems; whilst the undigested portions of the food and various excretions are further acted on by the bowel, and become the fæces.

Just as the acid gastric juice was stimulated to flow by the alkaline reaction of the insalivated food, so the three great alkaline secretions entering the intestine are stimulated to flow by the acid chyme. Moderate acidity of the contents, as they enter the duodenum, is manifestly the most favourable to intestinal digestion, excessive acidity tending to neutralise the alkaline fluids, and render them inert.

The nervous mechanism which regulates each of the three secretions is comparatively obscure; but they appear to be governed, like the gastric functions, both by local ganglia and by centres in the medulla, between which and the viscera there pass the vagus and sympathetic, as afferent and efferent, nerves. The vessels of the parts, so far as is known, are dilated during functional activity. The muscular movements are still, as in the stomach, partly progressive and partly churning, but the former decidedly preponderate.

II. PHARMACODYNAMICS.

In pursuing the contents of the alimentary canal from the stomach into the duodenum, the pharmacologist becomes conscious of a decided loss of control over them when they have passed the pylorus. The chyme is now practically beyond recall upwards by vomiting; and the chemical or physiological effects which could be produced by drugs in the mouth and stomach can only be imperfectly copied in the intestines. Yet a closer examination of the influences on duodenal digestion which are in our power is reassuring.

The *food* can be modified in any direction we may think fit, and the proportion of fatty and starchy principles specially arranged to affect intestinal digestion; or the liver, pancreas, and duodenal glands may be allowed to enjoy physiological rest by abstinence from food. The food may be specially cooked in combination with an extract of pancreas and an alkali, and thus thoroughly "peptonised" or pancreatised before it is taken. Starch may be partly converted into maltose and dextrin—Extract of Malt or maltine. If evacuation of the duodenum by the mouth be practically impossible, we may expel its contents downwards by the use of purgatives, which will be presently studied.

A more complex problem meets us when we attempt to affect the *secretions* of the liver, pancreas, and intestinal glands. We cannot directly increase the alkalinity of the secretions, as we increase the acidity of the gastric juice by a dose of diluted hydrochloric acid after meals; for any alkali given by the mouth is neutralised in the stomach before it reaches the duodenum. For the same reason we cannot administer pancreatic juice by the mouth as we can give pepsin, for its ferment is destroyed at once in the stomach. Malt extract contains an amount of active diastase, which, however, is also destroyed in the stomach, unless the extract be given at the very end of gastric digestion, when the acid is exhausted. We possess, however, equally physiological and less artificial means for stimulating the duodenal secretions. First, by influencing gastric digestion we can transmit the chyme into the duodenum with greater acidity, an **indirect duodenal stimulant** measure. Secondly, acids, such as Diluted Nitric, Nitro-hydrochloric, or Phosphoric Acid, given after meals, will be conveyed in the chyme to the mouths of the ducts, and act as **direct duodenal stimulants**; and it is possible that these may have a further influence in the same direction by being absorbed from the stomach and reaching the liver and pancreas through the blood. Ether is believed by some to stimulate the pancreas, and probably assists in emulsifying oils. On the other hand, an alkali given before meals will stimulate duodenal digestion by improving gastric digestion; whilst an alkali given after meals would interfere with duodenal digestion by diminishing the natural and necessary acidity of the chyme.

We possess a considerable number of substances which increase the flow of bile, and are designated **cholagogues.** Cholagogues are either *direct*, when they act upon the liver itself; or *indirect*, when they stimulate the liver by sweeping the intestinal bile out of the body. These facts may be accepted temporarily in connection with the digestive function of the bile; they will be fully discussed along with the purgative function of the bile in the sixth chapter. Mercurials not only clear the duodenum of chyme and bile, and furnish it with a supply freshly secreted, but also stimulate the duodenal glands, and thus have a remarkably stimulant influence on digestion.

III. PATHOLOGICAL RELATIONS.

Duodenal dyspepsia is not uncommon, and may be either *secondary* or *primary*. The *secondary* form is the necessary consequence of gastric indigestion. The acid decomposing mass which passes the pylorus in acute gastric dyspepsia completely neutralises the alkaline secretions of the duodenum; the remaining proteids, fats, starches, and sugars, undergo further decomposition, instead of the proper chemical transformation; absorption is arrested; the peristaltic movements are unnaturally increased; and the contents are hurried through the bowel, and violently expelled—the whole constituting the diarrhœa of acute indigestion, familiar to all. At the same time, pain is felt in the abdomen as the result of the powerful impressions on the afferent nerves, attended by a sense of misery and depression. *Primary* acute duodenal dyspepsia closely resembles the disorder just described, except that it is not preceded by gastric symptoms, and constitutes another form of diarrhœa. As in the case of the stomach, the chief cause of the derangement is improper feeding, including excess of those principles which tax the activity of the liver and pancreas, namely, fats, sugars, and, in infants, starchy materials. In other instances, the bile may be deficient. The flow of pancreatic juice is sometimes diminished by nausea and vomiting, as well as by other circumstances. Nervous and mental depression also interfere with the action of the secreting glands, and may lead to indigestion and diarrhœa.

In chronic cases disturbance of the natural relations between the duodenal juices and the chyme produces less urgent symptoms, but leads to more serious impairment of nutrition. Pain, "heart-burn," and depression, come on within a few hours after meals. The bowels are irregularly moved; and the motions are apt to be pale and foul, and may contain undigested fat and milk. The same symptoms in an aggravated form accompany organic disease of the duodenum, liver, and pancreas. Disorders and diseases of the liver have, however, an interest much beyond their bearing on digestion, and will be separately discussed.

IV. NATURAL RECOVERY.

Little requires to be said under this head. Diarrhœa is manifestly a natural provision for relieving the duodenum of unsuitable contents, as vomiting relieves the stomach. Even if this be excessive, and give rise to general disturbance, the duodenal function soon becomes normal, when the cause of disorder has been removed. A thorough appreciation of all the facts of the case manifestly suggests that the province of the therapeutist is not to prevent or check these salutary efforts unless excessive; and to help Nature to recover herself more speedily and more surely than she might otherwise be able to do.

V. THERAPEUTICS.

As in the stomach, the rational treatment of disorder of the duodenum is either *preventive* or *immediate*. Duodenal dyspepsia may be prevented from returning in persons predisposed to it by careful regulation of the quality, quantity, and preparation of the food. The patient must be ordered to eat sparingly of fatty, sweet, and starchy foods, and to avoid richly-cooked dishes, which generally contain fats in various stages of chemical decomposition. In extreme cases it may be necessary to ensure the digestion of a mixture of the proximate principles of a healthy diet, such as milk and bread or gruel, by peptonising them with an extract of pancreas before they are eaten. Malt extract, which supplies sugar in a form ready for absorption and little liable to fermentation, will be suitable in some cases, but attention must be paid to the time of its administration with relation to meals. Next to the food, the therapeutist will do wisely to attend carefully to the gastric functions, remembering that it is in this way that he will most rationally restore the chemical and physiological balance in the upper part of the intestine. He may elect to give an alkali shortly before meals to secure this end, or he may prefer to administer acids after meals according to the directions already given under the head of gastric digestion. In the former instance he increases the acidity of the chyme physiologically; in the latter instance by simple chemical means.

2. The *immediate* treatment of an attack of acute duodenal dyspepsia will generally follow, as we have seen, upon the treatment of acute indigestion in the stomach. We have studied the beneficial effects of neutralising the excessive acidity of gastric dyspepsia, by means of an alkali combined with a carminative and stimulant, and it is obvious that this will be continued after the chyme has left the stomach. When treated with a full dose of Bicarbonate of Soda and Sal-volatile, it enters the intestine with an acidity probably below the normal, reduces the higher acidity of the irritant chyme already there, and restores the normal action of the glands. If we are called too late to relieve duodenal indigestion in this way, the most rational course that we can adopt is to clear away the offending contents by purgation. Magnesia or its Carbonate act well in these cases, being immediately antacid, and afterwards laxative. More frequently a simple cholagogue purgative should be administered, such as Calomel, which has the further advantage of not disturbing the stomach by its taste or bulk.

Any pain and excessive muscular movements (colic) which may remain, must be treated by sedative remedies, such as Opium or Bismuth. The treatment of diarrhœa and the use of cholagogues and purgatives in chronic duodenal disorders, must be reserved till the next chapter.

MEASURES INFLUENCING DIGESTION IN THE DUODENUM.

FOOD.	DIRECT DUODENAL STIMULANTS.	INDIRECT DUODENAL STIMULANTS.	HEPATIC STIMULANTS.
Pancreatised Foods Olive Oil Almond Oil Cod Liver Oil Malt Extract	Diluted Mineral Acids Ether Mercurials	Sialagogues Stomachics Purgatives	Cholagogues Purgatives

CHAPTER VI.

THE INTESTINE.

WE now proceed to the consideration of therapeutical methods founded on a more complex physiological basis, namely, the actions and uses of *purgatives* and *intestinal astringents.*

I. PHYSIOLOGICAL RELATIONS.

As the chyme passes along the small intestine, the chyle and other soluble constituents are absorbed, and what remains is moved onward into the great intestine, where it forms the bulk of the fæces. Along the whole route, fluid is passing in both directions between the intestinal contents and the blood—from the bowel into the vessels, and from the vessels into the bowel. The consistency of the fæces will, therefore, depend upon the activity of absorption, the activity of excretion, and, manifestly, the rate of transit. The more active the absorption, the less active the secretion, and the slower the rate of transit, so much the firmer will be the fæces; whilst liquidity of the fæces will be the result of imperfect absorption, excessive excretion, or rapid transmission. We are accustomed to speak of the one extreme as constipation, and of the other as diarrhœa.

Absorption from the bowel is carried on by the lacteal and portal systems. The great bulk of the water and salts enter the portal system, by a process of diffusion or osmosis. The activity of this process varies greatly—with the amount of water, salts, and proteids in the bowel, as compared with the blood plasma; with the chemical nature of these salts; with the rate of the circulation through the veins—that is, with the state of the liver; and with the condition of the membranes through which the fluids pass.

Excretion is so active in the small intestine that the fæces are as liquid at the ileo-cæcal valve as in the duodenum, *i.e.* the effect of absorption as regards water is entirely neutralised. The watery excretions, along with a small quantity of solids and gases, are separated partly by osmosis from the vessels, partly by the glands, the latter furnishing the succus entericus. The activity of the glands is doubtless dependent upon many influences connected with their vessels and nerves, and with the quality of the blood, which are still imperfectly understood.

The *transit* of the contents of bowels is effected by peristalsis. The muscular coat is innervated by the vagus and splanchnics, the former increasing peristalsis, the latter tending to restrain or inhibit it, just as the vagus inhibits the heart. Whilst the intestine is connected by these means with the cord and brain, its movements are chiefly automatic and determined by Auerbach's and Meissner's plexuses. The state of tension of the wall, the internal pressure of fæces and gas, is the ordinary stimulus of this mechanism; but the nerves or muscles, or both, are also stimulated by the bile; and may be either excited or depressed by many substances introduced through the blood, as we shall see under the next head, as well as (inversely) by the amount of blood supplied to them. In defæcation the will comes to the assistance of the automatic intestinal movements, and effects evacuation of the bowels.

General effects of evacuation of the bowels.—The effects of evacuation of the bowels are by no means purely local. On the contrary, the whole system is influenced by this act, to no great extent, it is true, under normal circumstances, but very markedly when it amounts to actual purgation. When the bowels are very freely moved, a certain amount of water is directly or indirectly removed from the circulation. Bile is swept out of the bowel, and the liver indirectly stimulated. Certain solids and gases excreted by the intestinal wall, that is, truly excrementitious substances, are thrown out of the system. The circulation in the abdomen is disturbed: the vessels are relieved from the pressure of the fæces; the blood flows more freely from the arteries through the portal system and liver; whilst the volume of blood in the portal system and liver is temporarily reduced by the watery excretion. The heart and vessels generally are thus in turn relieved; the blood pressure in the systemic arteries falls; the cerebral circulation is especially depressed on account of its position, so that faintness may be the result; the respiratory movements become easier; the activity of the venous circulation is increased; and the temperature falls. Amongst the abdominal vessels, the circulation through the renal artery and vein is increased, and with it the volume of urine secreted, diuresis being more readily induced after purgation, unless the quantity of water drained off by the bowel have been excessive.

II. PHARMACODYNAMICS.

The means of acting physiologically upon the intestine which are at our command are of a much more artificial kind than any we have yet encountered, and introduce us to a large number of medicinal substances.

1. *Food.* The influence of the food is felt in the bowels, and affords us a ready means of acting upon them. Many kinds of food increase the action of the bowels, notably coarse, indigestible articles of diet, such as the husk of cereals made into "brown bread" and "whole-meal"; green vegetables; oils; fruits, fresh or preserved, which contain abundant salts and sugars; soups, broths, and other preparations of meat; eggs; ale and beer; tea and coffee, when properly prepared; and water taken at bed-time, or in the early morning before breakfast. On the contrary, cold articles of food, milk, spirits, red wines, and tea and coffee made strong and badly, are constipating in their effects. Perfect *digestion* in the mouth, stomach, and duodenum, is one of the most powerful means of preserving or restoring the natural action of the bowels.

We now pass from these natural means of acting upon the bowels, to others of a distinctly medicinal character.

2. *Measures which act upon the intestinal Blood-vessels: Drastics; Astringents; Constringents.*—A number of substances disturb transudation by acting upon the *blood-vessels* in the intestinal walls.

a. Drastics.—These cause the vessels to dilate, and retard the blood current, so that the fluid and part even of the solid constituents of the blood escape into the walls and cavity of the bowel. In other words, they establish an inflammation of the mucosa, somewhat resembling a common "cold" in the nose. The result is similar in the two cases: there is a profuse discharge from the mucous membrane, of the watery part of the blood, with a certain amount of solid elements, constituting a "catarrh," and producing in the case of the bowel a very liquid stool. The drugs which act in this way are obviously powerful or even dangerous, and comprise chiefly Croton Oil, Elaterium, Gamboge, and Colocynth. They constitute a group of purgatives known as drastics (δράω, I act) or drastic cathartics.

b. Intestinal Astringents.—Opposed to these measures we possess certain substances which contract the walls of the intestinal vessels, reduce the quantity of watery exudation, prevent the escape of solid elements, and thus diminish the liquidity of the fæces. Such substances, include Lead, Silver, and the

Diluted Mineral Acids, and constitute the first group of **intestinal astringents,** called *intestinal vascular astringents.*

c. Intestinal Constringents.—The substances thus named possess the property of coagulating or otherwise condensing the gelatiniform and albuminous tissue supporting the small vessels of the mucosa, increasing its compactness, diminishing the freedom of the circulation, and thus reducing the amount of exudation through the vessel walls. **Intestinal Constringents** are a very large group, including Persalts of Iron, Alum, Sulphate of Copper, Oxide of Zinc, Tannin, and the numerous vegetable products which yield it or some of its modifications, such as Catechu, Kino, Krameria, and Cinnamon.

3. *Measures which influence Absorption and Excretion.—a. Saline Purgatives.*—Certain salts possess the property of greatly disturbing the *process of osmosis* in the intestinal wall, such as the Sulphates of Magnesium, Sodium, and Potassium; Phosphate of Sodium; Tartrate and Acid Tartrate of Potassium; and the Tartrate of Sodium and Potassium. These produce two effects, namely, first, increased flow of water from the intestinal vessels into the cavity of the bowel, and consequently increased liquidity of the stools; and secondly, a flow of the salt, with a certain amount of water, from the cavity of the bowel into the blood-vessels, whence it is partly carried away into the general circulation, and partly again excreted into the bowel by the intestinal glands, once more to be absorbed. The result is an abundant liquid stool; in the case of Acid Tartrate of Potash, or very large doses of the other salts, almost entirely watery. The precise way in which these effects are produced by saline substances is still obscure. They appear to be due in part to the difference in specific gravity between the watery materials in the bowel and the liquor sanguinis, in part to some specific action of the salts upon the structures of the walls through which they pass, depending on their chemical constitution and affecting dialysis. According to some authorities, saline purgatives act in a measure by stimulating peristalsis.

These salts furnish us with a ready means of increasing the liquidity of the motions and the frequency of the stools, and constitute the group called **saline purgatives,** the most powerful of which are called *hydragogue salines.*

b. Saline Astringents.—A sufficient amount of salts, and (within broad limits) a particular strength of solution are required to secure an abundant excretion; otherwise their absorption in watery solution is stimulated beyond their excretion, and constipation instead of relaxation is the result. The same effect is liable to be produced by their habitual employment. We do not use this group of measures therapeutically.

4. *Measures which influence the Intestinal Glands.—a.* The secretions of the intestinal glands are moderately *increased* by Mercurial preparations; greatly increased by Croton Oil, Elaterium, Colocynth, Jalap, Scammony, and Podophyllin, which no doubt act also upon the vessels and muscles. Jalap and Scammony require to be dissolved in the bile. We have just seen that the saline purgatives are also glandular stimulants, being no sooner absorbed than they are again excreted. This class of purgatives may be called **cathartics** (καθαίρω, I cleanse); such of them as produce very watery motions, **hydragogue cathartics.**

b. Opium, Lead, and Lime directly *diminish* the intestinal secretions and promote constipation. Alkalies, Alkaline Earths and their Carbonates interfere with the acidity of the chyme when given in full doses, and thus indirectly arrest the intestinal secretions; whilst, by conversion into sulphates in the bowel, they may become active purgatives. Thus certain saline substances may not only be purgative in more than one way, but may even be purgative and astringent at the same time; the one effect or the other occurring according to the dose, the patient, and other circumstances which are often obscure.

5. *Measures which influence the Nervo-muscular Structures.*—Many of the materiæ medicæ influence the bowels through the *muscular coat*, the *nerves*, or both. Thus drastics excite intestinal peristalsis and griping even before they have left the stomach, as is seen in Croton Oil. Saline purgatives are believed to have the same effect. It is practically convenient to arrange in a special class those substances which act entirely or chiefly upon the intestinal muscles.

a. Nervo-muscular Stimulants. — These include Rhubarb, Senna, Aloes, Castor Oil, Sulphur, Sugars, Nux Vomica, Rhamnus Frangula, Cascara Sagrada, and Belladonna, and many others. They are best given with carminatives, to prevent the intestinal pain caused by excessive or spasmodic muscular contraction, popularly known as "griping," which they readily induce. Belladonna appears to act in a different way from the others, by removing the inhibition of the splanchnic; and ergot by causing anæmia of the muscles. The stool which follows the action of a muscular stimulant is much less watery than that produced by saline or cathartic purgatives, being chiefly the ordinary contents of the small bowel hurried down, unless the drug be given in large doses. For the same reason the disturbance of the portal circulation, liver, the general circulation, and the system as a whole, is less marked. The nervo-muscular purgatives are commonly known as **simple purgatives**; and the mildest of them, such as Castor Oil and

Sulphur, Figs and the like, are classed by themselves as **aperients** (*aperio*, I open), or **laxatives** (*laxo*, I loose), as inducing a simple opening or relaxation of the bowels.

b. Nervo-muscular Intestinal Sedatives.—The drugs which *arrest* the movements of the bowel, either directly or through the nerves, include Opium, Morphine, and Lead, which diminish peristalsis, and may even completely paralyse the bowel. Substances which form a protective lining on the mucosa, and antacids indirectly produce the same effect, by diminishing the irritation of the contents. Bismuth, Chalk, Lime, and Alkalies act, partly at least, in this way. All are **astringents.**

6. *Cholagogues.*—Following naturally on the last class of purgatives comes a group which act indirectly upon the muscular coat, by increasing the flow of its natural stimulant, the bile. These substances are known as **cholagogues** (χολή, bile, and ἄγω, I cause to flow). As will be explained in the next chapter, they either act directly upon the liver-cells and gall-bladder—**direct cholagogues**; or sweep out of the body what bile is lying in the intestine, and thus indirectly stimulate a fresh secretion—**indirect cholagogues.** Direct cholagogues may be illustrated by Podophyllin, Rhubarb, and Sulphate of Sodium; indirect cholagogues are chiefly Mercurials. It will be observed that cholagogues and purgatives have complex associations with each other: most purgatives are probably indirect cholagogues; many purgatives happen to be also direct cholagogues; and all cholagogues exert a certain amount of purgative effect, inasmuch as they increase the flow of the natural intestinal stimulant.

We do not deliberately employ **anticholagogue** measures, for *checking* the flow of bile. Opium possesses this action.

Enemata (ἐνίημι, I inject). Many of the remedies just mentioned may be adminstered by enema, that is, injected into the rectum. (1) Food, such as beef tea, eggs, gruel, and milk, and alcoholic stimulants, constitute **nutrient and stimulant enemata.** (2) Intestinal stimulants may be given as **purgative enemata,** chiefly Castor Oil, Olive Oil, and the officinal Enemata of Aloes and Sulphate of Magnesia. (3) Enema Opii is a most valuable **sedative and astringent** preparation. Solutions of Sulphate of Zinc or Copper, Nitrate of Silver, Alum, and Decoctum Quercûs, are also astringent. Enema Tabaci is now very rarely used as a powerful **depressant enema.** The rectum may be mechanically emptied by **simple enemata,** such as warm water, warm soap and water, and thin gruel, which soften the fæces and stimulate the parts. Besides these we possess **anthelmintic enemata**, which remove worms, such as the Enema Terebinthinæ, Enema Aloes, and an enema of bitter infusions, or salt and water. Ice-cold water may be injected into the rectum as an **antipyretic enema**, *i.e.* to reduce the temperature, and as a **styptic enema** in hæmorrhage.

III. PATHOLOGICAL RELATIONS.

As far as our present purpose is concerned, the disturbances of the intestine, independently of its digestive function, which has been already discussed, are chiefly two, namely: excessive action, the striking phenomenon of which is *diarrhœa*, and defective action, characterised by *constipation*.

1. *Excessive Intestinal Action.*—Diarrhœa, as we have seen, is generally referable to gastric or duodenal dyspepsia. The ultimate cause is most commonly improper food, including the various irritant substances which may be admitted along with it, such as unwholesome drinks, the organisms of putrefaction, and the poisons of typhoid fever, dysentery, and cholera. Irritant poisons have the same effect. Certain intestinal irritants are generated in the body itself, such as urea, the poison of gout (chiefly uric acid), and the poison of pyæmia. Nervous disturbances may produce diarrhœa, for example, anxiety and fear. Disorders of the general and abdominal circulation are frequently attended by a watery flow or flux from the bowels, as in diseases of the liver and heart, or as the result of chill. Lastly may be mentioned organic disease of the intestines. The student must carefully note that diarrhœa, although of much importance in itself and as a cause of further disorder, is but a symptom, the anatomical condition on which it depends varying greatly.

In connection with excessive activity of the intestines must be taken here certain conditions, such as hernia, peritonitis, and perforation of the bowel, in which any peristaltic movement of the intestine, however slight, must be considered excessive because highly dangerous, and in which paralysis of the intestine for the time being is urgently required.

2. *Deficient Intestinal Action.*—Constipation is even more common than diarrhœa, and is peculiarly apt to appear in a chronic form. Of its causes, we may select as illustrative examples certain kinds of food, already noticed; chronic gastric and duodenal dyspepsia, especially in connection with biliary disorder; sedentary or careless habits; and certain specific substances, such as lime and lead, admitted in the food or otherwise. Habitual constipation is generally due to loss of irritability and vigour of the nervo-muscular structures from very chronicity of the state and neglect of regular defæcation;

to impairment of the general health by sedentary occupations, foul air, etc.; to a variety of obscure causes, commonly referred to as locality, and change of habits; and to certain organic diseases of the bowel. The most severe and obstinate cases of constipation are caused by paralysis of the bowel in disease of the spinal cord and lead-poisoning. Although constipation, like diarrhœa, is but a symptom, and must be treated as such, its unfavourable effects on digestion, sanguification, and the functions generally, are almost endless.

Along with constipation must be considered a class of cases where disease of the digestive organs, liver, heart, lungs, general circulation, brain, blood, or kidneys, demands free evacuation of the bowels, and, it may be, even a hydragogue or cathartic action, chiefly as a means of unloading the circulation or of evacuating excrementitious substances. Frequent reference will be made to this application of purgation under the several organs in the following chapters.

IV. NATURAL RECOVERY.

Diarrhœa is a striking instance of the first method of natural recovery—by removal of the cause. By this means not only is the bowel purged of irritant matters, but constipation may be naturally relieved by a spontaneous diarrhœa produced by the irritant effect of the retained fæces. Both diarrhœa and constipation, if left entirely to themselves, may spontaneously cease, and the normal action of the bowels return. Therapeutical assistance is, however, constantly valuable, and frequently essential. Thus the diarrhœa of infants may quickly end in fatal exhaustion, and atony of the gut may be the result of neglected constipation.

V. THERAPEUTICS.

1. *Excessive Intestinal Activity; Treatment of Diarrhœa.*—The treatment of diarrhœa should begin, if possible, with *the removal of its cause.* If this is being accomplished by the bowel itself, we must encourage intestinal activity for a time by such purgatives as Castor Oil, Rhubarb, Calomel, Magnesia, and Senna. The first two drugs are specially valuable, as they also possess an astringent action, which comes into force after the purgation. On the same principle, diarrhœa from hepatic or renal disorder or disease, is rationally treated by non-interference or even by a judicious increase of elimination by the bowel, hepatic and renal stimulants being also combined; that is, by the use of a purgative which is partly cholagogue, followed by a diuretic—a mercurial pill supplemented by a

Seidlitz powder. Again, diarrhœa due to acidity in the duodenum is rationally treated by an alkali or alkaline earth, such as Lime-water, Chalk, and Bicarbonate of Soda—a highly successful method in the intestinal dyspepsia of infants. If the cause cannot be removed, its effects may be physically prevented by coating the surface of the bowel with Bismuth.

To *counteract* the irritant influence, astringent measures must be employed; and the two kinds of astringents in general use for this purpose are the constringents and the nervo-muscular intestinal sedatives. Of the former, Tannic Acid is less often used than its allies, between which there is little to choose, such as Catechu, Kino, and Krameria. With the constringent there is usually combined some preparation of opium as a nervo-muscular sedative, in the form of Dover's Powder, Kino, and Opium, or Compound Opium Powder, which relieve pain, diminish the peristaltic movements, check the secretions, and arrest the cramps or tormina. It will be found desirable in almost every case of diarrhœa demanding immediate arrest, to combine a certain amount of opium, however small, with the other drugs. We are now in a position to understand the use of the intestinal *vascular* astringents: Lead, Silver, and Diluted Sulphuric Acid. These are specially indicated in inflammatory conditions of the bowel, such as accompany ulceration in typhoid fever, dysentery, and tuberculosis. Diluted Sulphuric Acid is given when the effect is intended to be speedy and brief. A small quantity of Opium or Morphia is again a powerful adjuvant; for instance, as the Lead and Opium Pill, Diluted Sulphuric Acid and Laudanum, and Dilute Acetic Acid, Acetate of Lead, and Acetate of Morphine combined. In certain cases these remedies may be administered in an enema, the Enema Opii being particularly valuable. Coto Bark is successful in some cases of persistent tubercular diarrhœa. Nervous diarrhœa may be relieved by Bromide of Potassium. Some forms of chronic diarrhœa, and the flux of uræmia (when it can be safely checked), are best treated with Persalts of Iron.

The food is to be ordered in diarrhœa with a view to prevent irritation, and thus contribute to the cure; and dieting must be regarded as of equal importance with the medicinal treatment. The food must be entirely fluid, as a rule, and will consist chiefly of broths and milk. The former must be carefully prepared, without fat or seasoning, and given cold. The milk must be in a form which will not yield a large indigestible curd—itself a source of intestinal derangement, but given with effervescing alkaline waters, or lime-water, or boiled and mixed with some kind of starch, such as arrowroot or rice. Eggs must be used with caution. Ice is the best means of relieving thirst, or sips of toast-water; draughts of all kinds must be avoided. Stimulants may be required by the aged, by infants, and in all cases of protracted diarrhœa, brandy and port wine being the most suitable forms.

2. *Deficient Intestinal Action: The Use of Purgatives.*—The treatment of constipation consists chiefly in careful regulation of the diet, which should include fruits, green vegetables, meats, and "whole" brown bread, whilst milk and strong tea are to be avoided. As a rule, however, its chronic "habitual" form calls for active interference.

In the treatment of constipation, the *cause must first be removed* if it can be discovered. The diet, digestion, and liver must be regulated, and sufficient muscular exercise, mental relaxation, and other hygienic provisions ensured.

Habitual constipation being generally referable to *torpidity of the muscular coat*, will be rationally treated by the administration of nervo-muscular stimulants. But these must be preceded by a free evacuation, since the tone of the intestinal wall cannot be restored until over-distension has been removed. For this purpose a more powerful purgative must be given at first, such as Colocynth and Blue Pill, followed by a saline, to thoroughly empty the gut; and this practice will be repeated with advantage every few weeks for a time. A regular course of aperient medicine may then be commenced. There is considerable choice of drugs which increase peristalsis, the best for habitual use being Aloes, Senna, Rhamnus Frangula, and Cascara Sagrada. Nux vomica (Strychnine) is often added, in cases where the muscular tone has been lost by protracted overdistension; and Belladonna is a valuable adjuvant of Aloes in particular cases. Rhubarb, which is a popular aperient, is apt to produce further constipation.

Muscular torpidity is also rationally treated with cholagogues, and Rhubarb and Aloes act partly in this way. The saline cholagogues, such as Sulphate of Sodium, and the many bitter mineral waters now sold (such as Friedrichshall and Hunyadi Jànos) are highly popular habitual purgatives, but are apt to lose their effect if given for a length of time, and then to increase rather than relieve constipation. In anæmic subjects the Pilula Aloes et Ferri, and in uterine inactivity the Pilula Aloes et Myrrhæ, are specially indicated. Purgative or simple enemata must occasionally be ordered, but the practice must not be continued lest it become habitual. It may be necessary to keep up the action of nervo-muscular intestinal stimulants for an indefinite period; and Senna is the best drug for this purpose, especially in the form of the compound Liquorice Powder.

Severe and protracted constipation, in which the bowels are heavily loaded with fæces, as in lead-poisoning or spinal paralysis, or as the result of indolent and careless habits, may demand a cathartic. The officinal preparations of Colocynth are suitable in such cases, containing as they do Aloes and Scammony, so that if they be followed by a saline draught, the entire length of the bowel will be evacuated. Sometimes even Croton Oil is required, and a large purgative enema may be preferable to repeated purgation by the mouth in weak subjects. This is an absolute rule in the constipation of typhoid fever.

The treatment of constipation constitutes but a small part of the use of purgatives. In a considerable proportion of the cases in which purgation is practised, the indication is to hasten or increase the natural activity of the bowels, in order to obtain some or all of the other effects of considerable evacuation, which we have already studied. The practical question then comes to be what degree of activity of purgation is desirable. The activity of a purgative may be estimated by the rapidity of its effect, by the number of the evacuations, by the amount of water in the stools, and by the degree of constitutional disturbance which it produces; these results, as a rule, varying directly with each other.

When there exists an urgent indication for the *reduction of the general blood pressure*, for instance, in cerebral hæmorrhage with enlarged heart, the most active purgatives are employed. A drastic must then be given, such as Croton Oil, which has the further advantage of being very easily administered to an unconscious patient. When the portal system, heart, or systemic veins are overloaded, and the fluids of the blood are finding their way out of the vessels so as to constitute dropsy, *hydragogue cathartics and salines* are given, to establish a free flow of water from the bowel and thus relieve the circulation. Jalap in the form of the Compound Powder, Colocynth, and (most powerful of all) Elaterium, are commonly employed, less frequently Scammony. Frequent saline draughts, either alone or after a purgative pill, have the same effect, such as the sulphates of Sodium and Magnesium, Cream of Tartar, and Rochelle Salt.

At the commencement of inflammatory affections, for instance, acute bronchitis or local abscess, it is usual to unload the bowels and relieve the liver, heart, vascular system, and respiration, by means of a *simple purgative*. The Colocynth and Hyoscyamus Pill, with or without Calomel or Blue Pill, is well adapted for these cases, being given at night and followed in the morning by a Seidlitz powder.

Chronic congestion of the pelvic organs, bowels, and liver, a form of disorder not uncommon with sedentary persons, especially women, may call for a course of treatment by *aperient mineral waters,* usually containing Sulphates of Sodium and Magnesium, at some watering place, or systematically at home.

Contra-indications and abuses of purgatives.— Purgatives must be used with special caution in delicate subjects, such as infants and the aged; in persons weakened by disease; in inflamed ulcerated conditions of the bowels; when there is a tendency to hæmorrhoids and other affections of the rectum; in pregnancy, and during menstruation. In such subjects and conditions, constipation should be relieved if possible by enemata or mild aperients, such as Castor Oil, Sulphur, Senna, and dietetic laxatives. Aged persons do not bear saline purgatives well unless they be given warm or combined with a carminative. The evil effects of the habitual use of purgatives has been already referred to.

Anthelmintics.—In connection with the remedies directed to the intestine, must be discussed the *anthelmintics* (αντὶ, against, and ἕλμινς, a worm), or medicines which expel or kill worms. These belong to two classes, namely (1) **vermifuges,** which simply expel the parasites (*vermis,* a worm, and *fugo,* I drive out); and (2) **vermicides,** which destroy them (*vermis,* a worm, and *cædo,* I kill). The vermifuges belong to the cathartic purgatives, such as Scammony and Jalap: they may be given either alone, combined with, or several hours after a dose of a vermicide. The principal vermicides are Male-Fern, Turpentine, Kamala, Kusso, Pomegranate Root Bark; also Santonica and Santonin. The two last drugs act specially on the lumbricus, the others kill the tape-worm. The thread-worm (oxyuris) which infests the rectum is best reached by anthelmintic enemata of Turpentine, Aloes, or Salt and water, preceded by injections of a bitter infusion, such as Calumba or Quassia, with or without iron, to remove the mucus in which they flourish.

ANTHELMINTICS.

VERMIFUGES.	VERMICIDES.	INDIRECT ANTHELMINTICS.
Jalapa	Filix Mas	Quassia
Scammonium	Santoninum	Calumba
Cambogia	Ol. Terebinthinæ	Persalts of Iron
	Kusso	Sodii Chloridum
	Spigelia	
	Kamala	
	Areca	
	Granati Radix	

SYNOPSIS OF SUBSTANCES WHICH ACT UPON THE INTESTINES.

DRASTICS.	SALINE PURGATIVES AND HYDRAGOGUE SALINES.	CATHARTICS AND HYDRAGOGUE CATHARTICS.	LAXATIVES OR APERIENTS.
Action.—*Chiefly cause catarrh of mucous membrane; increase glandular secretions and peristalsis.*	Action. — *Chiefly disturb osmosis; also stimulate the glands and increase peristalsis.*	Action. — *Chiefly increase glandular secretion, increase peristalsis, cause catarrh of mucous membrane.*	Action.—*Increase peristalsis moderately.*
Elaterium Oleum Crotonis Colocynthis, in excessive doses Cambogia Guaiacum	Potassii Tartras Acida Potassii Tartras Potassii Sulphas Sodii Sulphas Soda Tartarata Sodii Citro-tartras Effervescens Sodii Phosphas Sodii Chloridum Magnesii Sulphas	Mercurials Jalapa Scammonium Podophyllum Rhamnus Oleum Terebinthinæ Tabacum Elaterium Colocynthis	Oleum Ricini Senna Sulphur Manna Ficus Tamarindus Rhamnus Frangula Cascara Sagrada Rhamnus Catharticus Cassia Magnesia Magnesia Levis Magnesii Carbonas Magnesii Carbonas Levis Physostigma Ergota Belladonna Stramonium Hyoscyamus Sapo Taraxacum Ipecacuanha Mel Glycerinum Morus Oleum Olivæ Oleum Amygdalæ
		SIMPLE PURGATIVES.	
		Action.—*Increase peristalsis actively.*	
		Rheum Senna Aloes Small doses of drastics, cathartics, or salines. Fel Bovinum.	

SYNOPSIS OF SUBSTANCES WHICH ACT UPON THE INTESTINES (*continued*).

DIRECT CHOLAGOGUES.	INDIRECT OR MERCURIAL CHOLAGOGUES.	INTESTINAL VASCULAR ASTRINGENTS.	ANTI-CHOLAGOGUES.
Action.—*Stimulate liver.*	Action.—*Empty biliary passages. stimulate intestinal glands, and stimulate liver* (?)	Plumbi Acetas Argenti Nitras Acid. Sulphuric. Dilut. Acid. Nitric. Dilut. Acid. Acetic. Dilut. Acid. Phosphoric. Dilut.	Opium Plumbi Acetas Intestinal irritants
Ammonii Phosphas Sodii Phosphas Soda Tartarata Sodii Sulphas Acidum Nitrohydrochloric. Dilutum Podophyllum Ipecacuanha Rheum Jalapa Scammonium Colchicum Colocynthis Aloes Acidum Benzoicum Euonymin Iridin Sodæ Salicylas Hydrargyri Perchloridum	Mercurials Cathartic Purgatives	INTESTINAL CONSTRINGENTS.	ADJUVANTS OR CORRECTIVES.
	INTESTINAL GLANDULAR DEPRESSANTS.	Tannic Acid and all vegetable substances containing it Alum Persalts of Iron Zinci Oxidum Cupri Sulphas	Antimonium Piper Valeriana Nux Vomica Capsicum Hyoscyamus Belladonna Stramonium Cardamomum Zingiber Cannabis Indica Caryophyllum, Cajuput, and other Aromatics
	Opium (?) Belladonna Plumbi Acetas Calx Creta Alkalies indirectly through chyme Alkaline Earths indirectly through chyme	NERVO-MUSCULAR SEDATIVES.	
		Opium Belladonna Hyoscyamus in last stage Plumbi Acetas Calx Creta Bismuthum; and Alkalies indirectly through chyme	

CHAPTER VII.

THE LIVER.

I. PHYSIOLOGICAL RELATIONS.

THE substances which enter the liver through the portal vein consist of the products of digestion in the widest sense, namely, proteids including leucin and tyrosin, sugars, salts, a trace of fat, and abundant water. When we parted with the proteids in the duodenum, they were in the form of peptones; when we meet with them again in the vena portæ, they have been transformed into ordinary serum albumen, apparently in the process of absorption. The sugars enter the liver partly unchanged, partly perhaps as derivatives—lactic and butyric acid. The proteids, sugars, water, salts, etc., will obviously be poured into the liver very abundantly during digestion. At the same time, there enters the liver through the hepatic artery a supply of oxygen which appears to be precariously limited, if we may judge by the size of the vessel. In the presence of this double supply, and in proportion to it, the hepatic cells display their special activity, and yield glycogen, urea, and bile. The urea and bile are carried off as such, the former by the hepatic veins to escape by the kidneys, the latter by the bowels. The glycogen has a less simple history. It accumulates in the liver cells, where it appears as a form of amyloid material specially adapted for storing up in an insoluble state the sugar and part of the proteids. By this arrangement the blood and body generally are saved from being flushed with sugar after each meal, and the sugar itself is not wasted. Under the influence of a ferment the glycogen is gradually re-converted into some kind of sugar; the amount of amyloid material hydrated varying with the necessities of the system. This function is regulated by a nervous mechanism, having its centre in the medulla, with efferent and (presumably) afferent nerves.

Another point in connection with the liver to be carefully noted by the therapeutist is *the circulation of the bile*. The bile, having entered the bowel and mixed with the chyme, is not entirely evacuated by the fæces. On the contrary, its most important constituents, the biliary salts, are re-absorbed from the bowel and carried back to the liver, again to be secreted and reach the bowel. Thus the bile may be said to move in a circle, comprised by the bile ducts and gall bladder, the intestine, and the portal vein.

II. PHARMACODYNAMICS.

Although the liver is apparently so inaccessible, we have great control over the influences under which its multiform activity is displayed.

(1) By means of the *food* we can completely interrupt the hepatic functions, or interfere with them at our pleasure. The amount of urea, the secretion of bile, the proportion of store glycogen in the liver, may be modified directly, within certain limits, by the amount of food allowed; and the urea and glycogen may be respectively made to vary with the relative proportion of nitrogenous and amylaceous constituents in the diet. The supply of oxygen which reaches the liver by means of bodily exercise, is equally under our control. The larger the volume of oxygen entering the liver, the more ready and complete will be the subtle processes of chemical composition and decomposition within it. We thus come to appreciate a fact of the first importance—that we can influence the liver through the medium of its *supply*. But we can do so in another way. We can tap, as it were, the channel of supply, the portal vein. The radicals of the portal vein in the rectum (superior hæmorrhoidal) anastomose with the veins around the anus; and leeches applied to this part will drain blood from the portal system, and thus indirectly from the liver. Closely allied to bleeding in principle is hydragogue purgation, which diverts a quantity of water from the portal radicles in the intestinal wall, and secures its evacuation.

(2) The liver may be influenced through its *products*, by securing the proper disposal of the urea, bile, and glycogen. In the bodily organs, as in the practical arts, the rate of manufacture cannot be maintained unless the products be removed. We have seen, in the stomach, that digestion is arrested by accumulation of peptones amongst the food. In the like manner, an accumulation of urea, of bile, or of glycogen, in the system, interferes with the hepatic processes. Now, as we shall afterwards see, we can increase the elimination of urea by the kidney, and thus indirectly stimulate the liver. On the same principle, the disposal of the bile furnishes us with a means of rousing the hepatic functions. This brings us to consider the action of indirect cholagogues.

That portion of the circulation of the bile which occurs in the intestine is thoroughly under our control. We can sweep the bowel empty of its contents; and with these the bile, which otherwise would have been re-absorbed, is expelled from the body. The portal blood and liver are thus deprived of material in which the biliary salts exist ready made, namely, their own products; and the hepatic cells are driven to fresh secretion. The purgatives which sweep away the old bile, and so lead to the production of new bile, are called **indirect cholagogues.** Mercurials specially act upon the liver in this way.

(3) We believe that we can modify the metabolic processes in the liver by **specific hepatic stimulants and depressants,** irrespective of both the supply and the products. Thus, Phosphorus, Antimony, and Arsenic, influence the metabolic activity of the liver, causing a greater production of urea, and the last two a free flow of bile. Bicarbonate of Sodium and Diluted Nitrohydrochloric Acid have probably the same effect as regards the glycogen and the bile. Chloride of Ammonium remarkably increases the amount of urea, apparently by its own decomposition, but still probably through the agency of the liver cells. Iron increases the amount of urea. Amyl Nitrite stimulates the glycogenic function. On the other hand, there can be no question that the whole process of hepatic activity may be remarkably reduced by means of Opium, and to a less degree by Quinine and Alcohol.

The direct effect of certain drugs upon the secretion of bile is unquestionable. Podophyllin, Rhubarb, Aloes, Colocynth, Colchicum, Jalap, Scammony, Ipecacuanha, Sulphate of Sodium, Phosphate of Sodium, and Chloride of Ammonium, Nitrohydrochloric Acid, and (non-official) Euonymin and Iridin, stimulate the liver substance and increase the amount of bile secreted, and are therefore **direct cholagogues.** Mercurials, including Calomel, as well as acids, and such substances as Guaiacum, Sarsaparilla, etc., possibly act less powerfully as direct hepatic stimulants. Opium and Morphine reduce the activity of the secretion.

III. PATHOLOGICAL RELATIONS.

The therapeutics of the liver will be best illustrated by a study of the treatment of its functional disorders. The common causes of derangement of the liver are to be found in the materials supplied to it, namely, food and air, and especially in the want of due proportion between the two. Most frequently there is excess of food—excess of rich food, especially of meat and alcoholic drinks, causing also primary indigestion. On the other hand, there may be imperfect oxygenation of the blood supplied through the hepatic artery, *i.e.* deficient respiration and circulation, generally referable to sedentary or luxurious habits, abstinence from muscular exercise, and confinement to ill-ventilated hot atmospheres. Not uncommonly the two classes of causes are combined, as is well seen in the disorders and diseases of the liver so common in the tropics.

Another way in which disorders of the liver originate is through retention of the products. If the kidneys, lungs, or bowels are inactive, the liver will be blocked, as it were, by urea, uric acid, sugar, and bile; and hepatic metabolism will become feeble. This condition is generally referable to impaired muscular and circulatory activity; to want of exercise, air and light, which beget renal and intestinal torpidity: it is the disorder of town life. In other cases debility of the liver is distinctly inherited.

In whatever way induced, derangement of the liver consists in certain disturbances of the chemical processes within it, which manifest themselves by altered composition of the excretions and many well-marked symptoms. The urine contains an excess (rarely a deficiency) of urea, an excess of uric acid, occasionally sugar, and even albuminous bodies, derived probably from the liver; whilst its reaction is disturbed, the colouring matter is in excess, and leucin and tyrosin make their appearance in it. The bile is altered in quantity and quality, giving rise to diarrhœa or constipation with foul pale stools, to inspissation of bile in the ducts and gall bladder, and the formation of gall stones. The general symptoms of biliary disorder are referable to the circulation in the blood of an excessive amount of the normal products—urea, uric acid, etc., and of imperfectly formed products allied to these. Such products of disordered metabolism, though differing from the normal only by a few atoms, or in the arrangement of their atoms, may be highly deleterious in their action on the body. Entering the blood by the hepatic veins, they disturb the nervous system, and are the cause of the sleepiness, languor, irritability of temper, the headache, and the general misery and melancholy, so familiar in the "bilious." They enter the muscles and produce aching, weariness, muscular debility, and trembling. Palpitation and flushing indicate their action on the circulation, whilst the general nutrition also suffers. If this condition persist, certain chronic states of the system are induced, which are known as gout and lithæmia. The heart and vessels become diseased, as well as the skin and joints. Continued disturbance of the reaction and constitution of the urine leads to a deposit in the urinary passages of some of its salts in a solid form, constituting gravel or calculus; and structural disease of the kidneys may ultimately result.

Absorption of bile into the blood may occur in these cases, but more so in actual plugging of the ducts, which leads to *jaundice*. In either case, some or all of the constituents of the bile enter the blood, circulate with it, colour all the organs, and are cast out in the various secretions, especially the urine.

Lastly, the glycogenic function of the liver may be disordered, and sugar make its appearance in the blood, urine, and all the tissues, constituting glycosuria or diabetes mellitus. Excess of sugar-yielding food may cause this, as we have seen, but well-marked diabetes is generally referable to derangement of the elaborate nervous and chemical processes of storing and re-distributing the nutrient elements of the food carried on in the liver. Hunger and wasting are therefore its prominent symptoms, and thirst is also very urgent from the diuretic effect of the sugar. In some instances diabetes may be traced to injury or disease of the hepatic ("diabetic") centre in the brain, or of the nervous connections between it and the liver.

IV. NATURAL RECOVERY.

Disorder of the liver disappears under favourable circumstances; that is, with a return to the normal influences. Recovery is assisted, on the one hand, by temporary abstinence from food, brought about by loss of appetite, or even loathing for food; and, on the other hand, by excretion of the morbid products. Excess of bile relieves itself naturally by bilious diarrhœa. Nature requires guidance, however, in hepatic disorders, for the languor, depression, and muscular debility which it originates tend to give rise to further indisposition to exercise, and thus to an aggravation of the evil.

V. THERAPEUTICS.

Hepatic disorder can only be *prevented* by taking a comprehensive view of the relation of the liver to the organs of digestion, absorption, blood formation, and excretion. The income, in the form of food and air, must be thoroughly supervised. The diet must be definitely ordered. Perfect digestion and intestinal activity must be secured. In many cases it is found that when this has been done, little more is required. Abundant bodily exercise must be recommended. The atmosphere breathed must be as pure, cool, and bright as possible. Sedentary or lazy habits must be changed for wholesome exercise in the open air, in the form of walking or riding. In the class of cases of disordered liver constantly met with in large towns, change is essential from the foul hot dull atmosphere of the workshop and dwelling, to the pure air of the parks or of the country. But the beneficial effect of exercise on the liver is not to be estimated solely by the amount of oxygen admitted. It will also be evident in increased activity of the kidneys, skin, and bowels, all of which will unburden the liver by hastening the removal from the blood of metabolic products.

If prophylaxis fail, and disorder be actually present, *immediate treatment* must be undertaken. The first step will be to remove, if possible, the causes of the disorder. A careful inquiry into the habits and constitution will often reveal serious errors in the mode of living. These must be reformed as has just been suggested. Active medicinal treatment must be begun at the same time; and in arranging the details of this, several objects may be combined. A brisk purge must first be employed, so as to sweep the intestine of imperfectly digested food, and stimulate its absorptive, excretory, and locomotive functions. The question of the selection of a purgative introduces us to the use of cholagogues. Calomel and Colocynth, Rhubarb and Colocynth, Podophyllin, and a variety of allied purgatives and cholagogues, mentioned in the second section, in proper combination with carminatives, are in constant employment for increasing the flow of bile. An almost invariable practice is to follow up the purgative by a saline, and the rationale of this plan is obvious. The Sulphate of Magnesium, Sulphate of Sodium, or Tartrate of Potassium and Sodium with Tartrate of Sodium (Seidlitz powder), not only complete the evacuation and stimulation of the bowel and the cholagogue effect, but their hydragogue influence (with that of the previous purgative) will drain a certain amount of water from the portal vein, and thus relieve the circulation within the liver. At the same time some of the salts will be absorbed into the blood, and excreted by the kidney, which, as we shall afterwards see, they powerfully stimulate, thus opening the second great channel of relief to the liver, the urinary discharge. The tartrates pass out in the urine as alkaline carbonates, and by this means the excess of uric acid which may have threatened or had actually produced gravel, is neutralised and safely conducted from the body. Altogether the time-honoured Blue Pill and Seidlitz powder form a combination which is in every respect scientifically sound, although probably of purely empirical origin. In urgent cases of acute hepatic disorder, the therapeutist may even divert part of the blood supply by tapping the portal vein, that is, by applying leeches round the anus.

An attempt may next be made to act upon the liver *directly:* to rouse its metabolic energy by one of the specific agents already enumerated. Perhaps the best of these in acute hepatic disorder is Bicarbonate of Sodium, given between meals in some of the combinations suggested in chapter iii., especially with Rhubarb, Senna, or Aloes. In more chronic cases, Chloride of Ammonium or Arsenic often proves of great service given immediately after meals, or that valuable combination of hepatic stimulants, the Pilula Hydrargyri Subchloridi Composita, given every night for a week on end. In cases of chronic hepatic disorder originating in the tropics, Diluted Nitrohydrochloric Acid is often used with success both internally and as a bath. The effects of hepatic disorder upon other parts of the system frequently demand direct relief, such as the headache, languor, or mental depression. Alcohol will frequently answer the purpose, but induces further hepatic disorders, and is otherwise obviously objectionable. The same remarks apply to Opium, except in very small doses "to take the edge off the misery." Quinine given after meals is of unquestionable service in many instances. Tea and coffee are useful and safe remedies. But on the whole too much reliance must not be placed on treating symptoms.

For the treatment of that remarkable disorder of hepatic metabolism which is called diabetes mellitus, the complete rearrangement of the diet is the first requisite, by the removal of amyloid and saccharine substances from the food. Nothing in the whole range of therapeutics is more striking in its way than the effect of Opium, Morphine, or Codeine, in dispelling the last trace of sugar from the urine in such cases, the quantity of the drug tolerated being sometimes enormous.

SUBSTANCES WHICH ACT UPON THE LIVER.

DIRECT CHOLAGOGUES.	DIRECT CHOLAGOGUES. — (*Cont.*)	GLYCOGENIC STIMULANTS.	SUBSTANCES INCREASING UREA.
Antimonium Sulphuratum Acidum Arseniosum Acidum Nitricum [Dil. Acidum Nitrohydro. Dil. Hydrarg Perchlor Sodium Salts Ipecacuanha Colocynthis Podophyllum Sodii Salicylas Ammonii Phosphas Euonymin Iridin Aloes Colchicum Jalapa Scammonium.	Rheum Acidum Benzoicum **INDIRECT CHOLAGOGUES.** Hydrargyrum Cathartic Purgatives **ANTICHOLAGOGUES.** Opium Morphina Plumbi Acetas Intestinal Irritants	Amyl Nitris Sodii Bicarbonas Acidum Nitrohydrochloricum Dilutum **GLYCOGENIC DEPRESSANTS.** Acidum Arseniosum Opium Morphina Codeina Phosphorus Antimonium	Antimonium Phosphorus Acidum Arseniosum Ammonii Chloridum Ferrum **SUBSTANCES DIMINISHING UREA.** Opium Morphina Colchicum Alcohol Quinina

CHAPTER VIII.

THE BLOOD.

We will now suppose that the products of absorption and hepatic metabolism have entered the blood. The peculiar relations which the blood bears to the solid organs gives a special character to its pathology and therapeutics. It possesses of itself no active functions, but is simply a great fluid medium which conveys nutrient material and oxygen to the tissues, and carries away the products of their activity. In the same way it is the medium by which the active principles of drugs reach the internal organs, without, as a rule, materially disturbing the functions of the blood itself. It is not surprising that the blood should have comparatively few primary disorders, whilst it is constantly liable to suffer in consequence of disease of the digestive organs from which we have traced its supply, and of the excreting organs by which its constituents finally leave the body.

I. PHYSIOLOGICAL RELATIONS.

The physiological relations of the *liquor sanguinis* are very obvious: it is the medium of nutrition. It carries between the different organs the materials which are the sources of energy, namely albumins, fats, sugar, water, and salts, as well as the products of the vital processes—carbonic acid, water, urea, salts, and other substances. It possesses a mean volume, an alkaline reaction depending on the presence chiefly of salts of soda, and a certain general uniformity of composition, which, however, varies considerably at different parts of the circulation—for instance, before and after exposure of the blood to the liver, lungs, muscles, or other active organs. The composition of the liquor sanguinis is indeed the balance of two opposed processes—a process of supply, income, or ingestion, which we have traced through the liver from the food; and a process of production, expenditure, or egestion, carried on by the active organs of the body, with their measurable products, energy and excretions. The *white corpuscles* are physiologically associated with the plasma, that is, are essentially nutritive, in function; they are probably also the source of the red corpuscles.

The function of the *red corpuscles* is perfectly distinct from the functions of the plasma. They are the great medium of respiration, carrying oxygen from the lungs to the tissues, and are thus the respiratory elements of the body. It is important for the therapeutist to remember that the red corpuscles consist chiefly of *hæmoglobin*, with a small quantity of salts, which have *potassium* as their principal base united with *phosphoric acid.* Iron is an essential component of hæmoglobin ($C_{600}H_{960}N_{154}FeS_3O_{179}$). Whatever may be the immediate source of the red corpuscles, there can be no doubt that the most important factors in their development are food, air, and free exposure of the blood to light. Ultimately they are broken up, their products forming the colouring matters of the various secretions.

II. PHARMACODYNAMICS.

1. Our power over the blood plasma in health is easily appreciated. The most obvious means of influencing it is through the *income* or supply. We can alter a man's diet, his digestion, and his hepatic functions, and by these indirect means we retain a hold on the vital fluid. We can also modify its several constituents during their ingestion—the albumen, sugar, water, phosphates, carbonates, chlorides, sulphates, etc.—by regulating the food or administering them in the form of drugs. A fact of great therapeutical importance is that we can *increase, within certain limits, the alkalinity* of the plasma by means of alkalies or alkaline earths, given as the Bicarbonates of Potassium or Sodium, as the various solutions of these or of Lithia, Lime, and Magnesia; or in a more moderate degree over a longer period, by means of the many natural alkaline waters, such as those of Vichy, Carlsbad, Baden Baden, Ems, and Bilin. **Alkalisers of the blood** act upon the plasma not only directly, but indirectly by combining with uric acid, and carrying it with them out of the system by virtue of their diuretic influence. Potassium is the most rapid and evanescent alkaliser; Sodium is slower and more permanent, as is fully described at page 41. The citrates and tartrates are also true alkalisers of the blood, being decomposed, as we shall presently see, in the presence of the red corpuscles, into alkaline carbonates. It is much more difficult to *reduce the natural alkalinity* of the blood. Mineral Acids have very little effect in this direction, as they enter the blood in the form of neutral salts of potash, soda, etc., which pass out undecomposed. Citric and Tartaric Acids remain partly unchanged in the plasma, and Benzoic, Cinnamic, and Salicylic Acids also pass through it, the two first being partly converted into hippuric acid. Free Iodine may be temporarily liberated in the plasma from the iodides.

Besides these, most of the materiæ medicæ enter the system through the plasma, where they exist in every possible form, whether unchanged, or as albuminates, chlorides, sulphates, etc., or as highly complex compounds. It is most important, however, for the student to observe that, beyond the alkalies and acids, but few drugs act upon the plasma. The great majority of them simply exist in it, and are conveyed by it to the tissues and organs of elimination, where they exert their specific influence.

But we may go beyond this, and alter the total amount of blood or plasma in the body by actually adding to it from the blood of another person or animal. This is done by *transfusion*, a powerful means of restoring the blood, but one which is not always readily available.

2. We can affect the value of the plasma through the *expenditure* or egesta. We have seen that purgation is a ready means of influencing the water, salts, albumen, and other constituents of the plasma in the portal system, and thus in the blood generally. We shall find in subsequent chapters that in the same way we can stimulate excretion by the kidneys and by the skin. We shall also discover, under the head of metabolism, that we can so far either tax or spare the great organs which are the source of vital energy and therefore of waste, such as the muscles, and thus the metabolic and nutritive value of the whole blood. But we can go much farther than this: we can actually *abstract* a certain quantity of blood by venesection, cupping, or leeching, as we have already seen in the case of the portal vein; and such alteration in quantity will cause a decided alteration in quality, for, as we shall find in chapter x., abstraction of blood increases the amount of water in the plasma.

3. A small number of drugs are known to act directly upon the *white corpuscles*. Quinine reduces their number, and paralyses their movements; Veratrine kills them (out of the body). All aromatic oils, resins, and gum-resins, especially Myrrh, increase their production by stimulating intestinal absorption.

4. We can increase the richness of the blood in *red corpuscles*, and the richness of the individual corpuscles in hæmoglobin, by giving abundant digestible and assimilable food, and by securing the activity of the lacteal tract, which is concerned in their production. Fresh air and sunlight can be secured by change of habits or residence. We can also increase the constituents of the red corpuscles admitted into the system. Iron, which the pharmacopœia provides in so many forms, directly increases the amount of hæmoglobin even in healthy individuals. Carbonate of Potassium, in proper combination with Iron, as in the Mistura Ferri Composita or Blaud's pill, unquestionably increases its value. Phosphoric Acid, whether as the Diluted Acid or as the Phosphate of Iron and other bases, is also a reputed blood restorer. All

these substances, and such others as indirectly improve the quantity and quality of the hæmoglobin, are known as **hæmatinics.**

Arsenic, Phosphorus, and perhaps other metals combine with the hæmoglobin, partially reduce it, or otherwise interfere with its constitution or quantity, so as to impair the oxygenating power of the corpuscles if given in full doses. Citrates and Tartrates have a peculiar deoxidising effect on the blood, being converted in part into carbonates at the expense of the hæmoglobin, thus, $2K_3C_6H_5O_7 + O_{18}$ (from hæmoglobin) $= 3K_2CO_3 + 9CO_2 + 5H_2O$. Lead reduces the number of the red corpuscles, but probably indirectly, by interfering with digestion. Iodine and Sulphur (Sulphides), Turpentine, and a few other drugs, such as Diluted Hydrocyanic Acid, reduce the oxy-hæmoglobin of the corpuscles, but only after excessive doses, so that in this respect they may be regarded not as drugs, but as poisons, and will be noticed in the next section. The Nitrites of Amyl and Sodium, and Spiritus Ætheris Nitrosi convert part of the hæmoglobin into methæmoglobin, but only when given in excess. On the other hand, Alcohol and Quinia bind the oxygen more firmly to the corpuscles, and thus reduce oxygenation. Nitrous Oxide gas acts indirectly on the corpuscles by taking the place of oxygen, but does not chemically combine with the hæmoglobin. It is manifest that the methods of venesection and transfusion will influence the corpuscles as well as the plasma.

III. PATHOLOGICAL RELATIONS.

As was mentioned in the introduction, the morbid conditions of the *plasma* are chiefly secondary; that is, caused by disorder either of the organs from which it draws its supply—the digestive organs and liver, or of those by which its products leave the body, especially the lungs and kidneys.

Thus excess of blood, which constitutes one kind of plethora, is referable to indulgence in food, combined with lazy habits. The opposite condition, anæmia, or deficiency of blood, is a very common disorder, which may arise from an endless variety of causes, whether of the nature of want (insufficient food or imperfect digestion) or of waste (excessive work, growth, exhausting diseases, or hæmorrhage). The constituents of the plasma are no doubt often disordered, but this subject is still obscure. The albumins are deficient in anæmia. Carbonic acid increases in respiratory difficulty. The water of the blood is increased in anæmia; greatly diminished in cholera, where its excretion is excessive. The alkalinity of the plasma is believed to be reduced in rheumatism, from some unknown cause. Uric acid is certainly in excess in gout. In calculous subjects there is apparently some obscure tendency to disturbance of the reaction of the blood, referable to derangement of primary and secondary digestion. Sugar is in excess in diabetes, probably from disordered supply; urea is in excess in Bright's disease, from defective excretion. The *white corpuscles* are liable to abnormal increase, as in leukæmia, but it is still doubtful whether these are instances of primary disease of the blood.

The diseases of the *red corpuscles* are certainly few and imperfectly known; practically they may be represented as deficiency, and deoxydation or reduction of hæmoglobin. *Deficiency* of hæmoglobin, whether traceable to want of blood as a whole, to poverty of the blood in *red corpuscles*, or to deficiency of the individual corpuscles in hæmoglobin, reduces the oxygenating value of the vital fluid. All the bodily functions become feeble: the patient is weak, dull, sleepy, and suffers from every possible functional derangement, especially shortness of breath.

Reduction of hæmoglobin, or, more correctly, of oxyhæmoglobin, is a result of the admission to the blood, in poisonous quantities, of certain substances which we have already mentioned, such as Phosphorus, Arsenic, or Turpentine in poisonous doses. Carbonic Oxide enters into combination with the hæmoglobin, whilst the oxygen is expelled from the corpuscles. Hydrocyanic Acid unites partly with oxyhæmoglobin, partly with reduced hæmoglobin. Other bodies, such as Sulphuretted Hydrogen, seize upon and combine with the oxygen, leaving the reduced hæmoglobin to be dissolved out of the corpuscles and diffused through the blood. Either of these conditions is highly dangerous, the new hæmoglobin compound in the first case being with difficulty replaced by oxyhæmoglobin; whilst the reduction and solution in the second case are incompatible with life if they have occurred to any extent.

IV. NATURAL RECOVERY.

The quantity and functional value of the liquor sanguinis, being but the balance between the income and output of the body, readily return to the normal after disturbance. The same is true of the corpuscles. As long as the disorders of the red corpuscles are of a purely quantitative kind, the restoration of the normal conditions is followed by a return of the blood-elements to their proper constitution. The natural means of recovery are to be found in the shortness of breath and debility which accompanies anæmia, and which compel the patient to spare the blood every possible source of waste. At the same time the increased frequency of the pulse and breathing compensate for want of hæmoglobin. Unfortunately there is here as elsewhere a limit to recovery, as when large quantities of a poison, such as carbonic acid, have entered the blood, or when the hæmoglobin has been reduced.

V. THERAPEUTICS.

The facts which we have reviewed under the four preceding heads are highly encouraging to the practical therapeutist.

In *plethora* he will reduce the amount of food, increase the excretions, and prescribe increased bodily exertion; five-and-forty years ago he would have bled the patient freely, and repeated the operation at regular intervals.

Anæmia must be treated by the opposite class of measures, which will be discussed immediately under the head of the red corpuscles. Speaking generally, we must sustain and restore the appetite and digestion, spare the body every possible exertion, maintain healthy excretion, and, if the condition be urgent, even transfuse blood into the veins. Deficiency of albumen is met by the same measures. Excess of carbonic acid demands artificial respiration, as we shall find under respiratory diseases.

When the indication is to *increase the alkalinity* of the plasma in rheumatism, gout, and allied morbid states, we administer salts of Potassium, Sodium, Ammonium, Lithium, or the Alkaline Earths, the Alkaline Citrates and Tartrates being the most suitable because large quantities can be admitted into the blood without deranging digestion. Acids, which have so little influence in the opposite direction, are fortunately seldom called for. The treatment of poisons in the blood, whether formed in the body or introduced from without, will rationally consist first in removing their cause, *e.g.* indigestion or renal disorder, or in decomposing or neutralising them chemically. This introduces us to the second use of alkalies in the blood. The acid of rheumatism, whatever it may be, and the uric acid of gout, are converted into soluble salts by the Alkalies and Alkaline Earths, and these salts are fortunately diuretic. In this way excess of acid is not only neutralised, but conveyed out of the system, and the reaction of the urine may be used as a test of the success of our action on the blood. This end is secured in acute cases by the free exhibition of the milder salts of Potassium, Sodium, Ammonium, and Lithium; in chronic cases by treatment at an alkaline bath, such as Ems, Homburg, Vichy, Carlsbad, Buxton, or Bath. Metallic poisons, such as lead, are removed from the blood and tissues in a precisely similar way; lead, for example, by Iodide of Potassium or Sulphur baths.

Poisons may also be removed from the blood by simple increase of the excretions—carbonic acid through the lungs by artificial respiration; urea by diuresis, free purgation, and diaphoresis; and so with the products of indigestion, which is relieved by a cathartic pill and a saline draught.

If the *hæmoglobin be deficient*, we must secure a sufficient supply of digestible and nutritious food, pure air, and direct sunlight; reduce the amount of work, by ordering rest or even confining the patient to bed; and attend to all the functions which are connected with the formation, growth, and purification of the blood. Correction of derangements of the stomach and bowels always demands special attention, and is a *sine quâ non* for success. At the same time, any actual waste of the blood must be arrested, if possible. Passive hæmorrhages must be checked. Growth and development may be rendered less trying by directing the blood to parts where it is specially required; for instance, to the uterus by means of emmenagogues. We must next hasten to restore the red corpuscles by supplying their important chemical elements—Iron, Phosphoric Acid, and Potash. Long before the composition of hæmoglobin was understood, it had been empirically discovered that Iron was a certain remedy for "want of blood." This is our daily experience still; science in this instance has confirmed and not suggested practice. Iron has other actions and uses therapeutically, but its chief employment is as a hæmatinic. The particular form in which the metal may be administered is discussed under its own head, but one or two combinations with iron must be noticed here. The Mistura Ferri Composita, an old-established empirical combination of Protosulphate of Iron, Carbonate of Potassium, Myrrh, and Aromatics; the Pilula Aloes et Ferri; and the non-official pill of Blaud, containing Protosulphate of Iron and Carbonate of Potassium, are specially successful remedies in anæmia, the rationale of which will now be obvious to the student. The Phosphate of Iron is also indicated, and is highly successful, in some instances. Altogether, the medicinal treatment of deficiency of hæmoglobin practically resolves itself into the continuous administration of iron in some useful form or combination, without impairing digestion or the action of the bowels.

In urgent cases of want of blood corpuscles, whether acutely developed by hæmorrhage, or progressing slowly to an extreme degree, transfusion must be practised.

Reduction of oxyhæmoglobin defies therapeutical measures if it have advanced beyond the very first stage; that is, the treatment of poisoning by carbonic oxide, prussic acid, etc., is rarely successful. It must, however, be attempted. Combined venesection and transfusion would theoretically be the proper treatment—to remove disorganised blood and poison, and to replace them by healthy corpuscles and plasma. But this is manifestly very rarely practicable. All that can be done, as a rule, is to sustain the circulation and respiration, by general stimulants and artificial respiration, and thus preserve vitality by means of the oxygen and hæmoglobin that may still remain active. In every case it will be proper to do this until transfusion can be undertaken.

SYNOPSIS OF SUBSTANCES WHICH ACT ON THE BLOOD.

SUBSTANCES WHICH ACT ON, OR ARE DECOMPOSED IN THE PLASMA.	SUBSTANCES WHICH ACT ON THE WHITE CORPUSCLES.	SUBSTANCES WHICH ACT ON THE RED CORPUSCLES.
Potassii Iodidum Sulphur (Hydrosulphuric Acid) Benzoinum; Acid. Benzoic. Styrax Salicylates Oleum Olivæ Oleum Morrhuæ Succus Limonis Potassium Sodium Lithium Calcium Magnesium Acids	Quinina Veratrina Myrrha Aromatics (indirectly)	Iodides Sulphur (Hydrosulphuric Acid) Quinina Alcohol Sodium Nitrite Spiritus Ætheris Nitrosi Acidum Hydrocyanicum Dilutum Oleum Terebinthinæ Potassium Ferrum Acidum Arseniosum Phosphorus Tartaric and Citric Acids

CHAPTER IX.

METABOLISM—THE ACTION OF MEDICINES—ALTERATIVES.

WE now pass on to consider the process of nutrition or metabolism, that is, the activity of the tissues, the development of force by protoplasm in the presence of blood. We shall find that this subject has an important bearing on the action and uses of many drugs and other therapeutic measures.

I. PHYSIOLOGICAL RELATIONS.

The best means of comprehending the obscure subject of metabolism is to take the instance of a muscle. A muscle has a definite structure; enjoys a free supply of blood; displays force during the period of its contraction, namely, mechanical energy, heat, and sound; and produces certain chemical substances, *i.e.* carbonic acid, water, sarkolactic acid, kreatin, other allied nitrogenous bodies, and possibly urea. The blood which passes through the muscles becomes venous, that is, loses oxygen and a small quantity of proteids, and takes up the waste products.

In doing this work, the muscle first incorporates the oxygen and certain elements of the plasma with its own substance, however loose that combination may be. In this respect the molecules of the muscle are being constantly changed. It is a fact of the first importance to the pharmacologist that when a muscle or other living tissue incorporates metabolic materials, and forms force and other products from them, its own molecules are changed or altered. If the blood or plasma supplied varies, so will vary not only the materials that are incorporated, the amount and even the character of the force and the products, but also the chemical (possibly even the anatomical) constitution of the active protoplasm. In one sentence, we may say that the muscle and the plasma act and re-act upon each other: that the protoplasm *acts on* or *alters* the lymph; the lymph *acts on* or *alters* the protoplasm.

This process of double decomposition appears to be going on in every organ and tissue of the body; though, naturally, the tissue being different in each case, so are the particular substances broken up by it, the products yielded by it, and the particular kind of force which it displays, for instance secretion, nervous energy, growth and development. The oxygen and the plasma are carried to the organs by the arterial blood; the heat is distributed and lost; the carbonic acid, water, and nitrogenous and other products are excreted by the lungs, skin, kidneys, and bowels; and the active organs are maintained in size and vigour amidst all the change.

There are various *means of estimating* the state of metabolism in the living body. We may measure, first, the amount of *force displayed*—the muscular activity or *tone*, the rate of growth, the temperature, the mental capacity; or, secondly, the amount of *material consumed*—the food taken and the air inspired; or, thirdly, the *products* of metabolism, that is, the excretions. The first two means are by no means always available with accuracy. This is what makes the examination of the urine, the principal excretion, so important in the majority of clinical cases; for knowing the state of the urine, we can work backwards, as it were, and estimate the functional activity and even the anatomical state of the organs in which its constituents have been produced.

Unfortunately, metabolism is not the simple process which we have described, but in many respects still very obscure. Thus the proteids are not at once broken down into carbonic acid, water, and nitrogenous compounds, as represented above. In some of the tissues at least there are intermediate products, one of which is fat, which is in turn oxydised into carbonic acid and water. It is also probable that all metabolism is associated with ferments, if not actually due to their activity, like digestion and the coagulation of the blood. Lastly, the intimate protoplasmic changes which are the basis of vital force are controlled by the central nervous system, by *trophic* centres lying in the cord and cerebrum, with afferent and efferent trophic nerves.

II. PHARMACODYNAMICS.

This brings us to the second part of our inquiry—our power over metabolism in a healthy individual. This is greater than would at first appear.

1. Our influence on metabolism through *the blood as a whole*, has been fully discussed in the preceding chapter, and does not require to be more than mentioned here.

2. We can affect nutrition through the *constituents* of the blood which supply material to the particular organs. Experience taught us, long before science, how to feed a man in training for muscular exertion; which kinds of food are specially suited for the exercise of the brain, for the periods of growth and development, of pregnancy and lactation, of degeneration and decay. It is but expressing the same fact in other words to say that by supplying an excess of certain kinds of food, we can increase the activity of an organ, the cells of which appear to exercise themselves more vigorously when their natural source of energy and nutrition is freely supplied to them. Alcohol, Cod-liver Oil, Olive and Almond Oils are thus valuable foods, or **nutritive tonics**.

3. An increased supply of *oxygen* in the blood increases metabolism. The valuable influence of fresh air on active organs is familiar, and we have learned in this connection the use of Iron, which is thus a **hæmatinic tonic**.

4. An increased amount of work is an interesting means of increasing protoplasmic activity. By throwing more weight upon a muscle, up to a certain point, we can increase the force of its contraction. This is *exercise;* and it must be accompanied by a sufficient supply of plasma and oxygen. A man in training not only selects his food and air, but throws an increased amount of work on his muscles by exercising them regularly.

5. We can influence metabolism by means of the *excretions*, that is, by hastening the removal of its products through the lungs, kidneys, skin, and bowels, as we have already seen in the case of the stomach and liver. The same principle manifestly applies to all the tissues.

6. The *trophic* centres are amenable to impressions carried in by their afferent fibres, and such of these fibres as originate in the surface of the body are thoroughly accessible, and ready to convey any influence which we may impress upon them, such as extremes of heat and cold, by means of the cold bath or douche, stimulation by Mustard or Cantharides, and the direct battery current.

7. The metabolic activity of a part may be increased by certain local measures which are familiar to us, as friction and shampooing. The physiological effects of these **local alteratives** or **local tonics** are very powerful. Their action is complex, partly direct and partly reflex through the trophic nerves. They cause, first, dilatation of the local vessels, leading to increased circulation in the tissues; more rapid removal of the products of nutrition by the lymphatics and veins; and an actual exercise of the tissue elements, *e.g.* of the muscles, by well-arranged movements. No doubt these effects can be increased by the use of certain local circulatory stimulants, in the form of liniments of Ammonia, Alcohol, Chloroform, and the great group of Volatile Oils of the Turpentine and Camphor series. But, further, these local alteratives and tonics react upon nutrition generally, probably through the nervous system, and greatly stimulate it, improving the appetite and digestion, and rapidly causing an increase in the strength and the weight of the body, and thus become **general tonics**. The action of poultices, blisters, some forms of electricity, and other local applications, on the nutrition of deeper parts, which is known as *counter-irritation*, is discussed in chapter xv.

8. The surrounding *temperature* has a powerful effect upon nutrition. Heat and cold are universally recognised as being stimulating, enervating, relaxing, tonic or bracing, as the case may be. Water, in every form, from vapour to solid ice, is a convenient means of bringing any temperature that may be desired into contact with the tissues, whether directly or indirectly through the vessels and nerves. In other words, we possess, and have greatly elaborated, the means of affecting nutrition by baths and climate, the actions and uses of which are the subjects of **balneology** and **climatology**.

9. *Medicines.*—We have made a further important discovery with respect to our influence over metabolism—that we can admit to the organs other than the normal constituents of the

blood, and allow them to participate in the vital processes. Thus, if such foreign substances as Mercury or Lead be introduced into the blood, the muscular and other tissues will take them into their substance, just as they take up proteids, salts of lime, and water, and incorporate them in a loose chemical way, their own proper composition being essentially unaltered. By whatever channel they may be introduced into the blood, most of the active principles of the materia medica are carried in the plasma to the tissues and organs, and are said to "act upon" or to "have a specific action" upon them. Thus, Iodine acts upon the glands, Bromine upon the brain, Potash on the heart, and so on. By this expression we mean that the medicines having reached an organ take part in the process of metabolism; that they become loosely incorporated with the anatomical elements of the part; that they form, either in these, or in the presence of these, certain chemical compounds with oxygen, different from the ordinary; that they are cast out again in the metabolic products, either unchanged or in a new chemical form; and that, *in thus passing through the organ and taking part in its activity, they have modified the force which it displays.* Thus, Alcohol, in passing into muscle, becomes oxydised and converted into carbonic acid and water, and in the process of decomposition increases the force of muscular contraction. Alcohol is accordingly said to act specifically upon muscles. So with all tissues and organs: some incorporate from the blood one substance, some another. Just as the life-processes of the various tissues and organs differ from each other, so will some select or be acted on by some principles, others by other principles. Gland protoplasm is acted upon by Iodine, nervous protoplasm by Bromine, muscle protoplasm by Potassium, red corpuscle protoplasm by Iron, and so on.

Here it is necessary to offer a word of caution. The expression "action" of a medicine is generally used in a much wider sense than that just indicated. When we say that a given therapeutical substance acts upon "an organ," we do not always mean that it acts upon the *protoplasm* of that organ. When we say that alcohol acts upon the skin, flushing it and increasing its heat and secretion, we do not imply that alcohol is decomposed by the connective tissue-cells of the skin. An organ possesses not only active protoplasmic cells but vessels and nerves; and a vast number of the effects of drugs upon organs are due, as we shall see in subsequent chapters, to their action upon the vessels and the nerves that supply these organs. Ultimately, of course, all drugs do act upon protoplasm in some form: on the protoplasm of muscular tissue, of nerve-ganglia, of the walls of blood-vessels, or of the cells of the nerve-centres which regulate the vessels. But for practical purposes it is highly important to keep the action of drugs upon the protoplasm of an organ quite distinct from their action upon the organ through its nerves or its blood supply.

Alteratives.—The subject of metabolism introduces us to a term applied to certain drugs, namely, **alteratives.** This word, like many other terms in therapeutics, never had an exact application, and therefore defies correct definition. Still, it is retained as a useful word, and its meaning may be discussed if it cannot be defined. We have seen that we can increase the amount of work done by an organ in several ways, through food, air, local stimulation, etc., which make it build up and break down more actively both its pabulum, the lymph, and its own proper elements: which, in one word, *exercise* it. Certain medicinal substances also are found to **increase metabolism,** the chief of which are Mercury and Iodine, Phosphorus, Antimony, Arsenic, Salicylates, Sulphides, and certain doubtful vegetable agents, such as Sarsa and Guaiacum. The particular way in which each of these drugs increases tissue waste is given under its own head, as far as it is known. It naturally occurs to us, that the action of these medicines is another form of exercise of the tissues. When Mercury and Iodine, for example, have entered into combination with living protoplasm, and been again disengaged or thrown out of combination with it in the metabolic products, they have *made it do a certain amount of work:* and to a corresponding extent they have effected a change and a renewal of its proper molecules; they have hastened its nutrition: their action may be said to be *alterative.* We find that an essential condition of the success of alterative drugs is a free supply of the normal sources of metabolism, food and air, just as it is of physical exercise, that the constructive part may keep pace with the destructive part of metabolism. If food and air fail, the health rapidly breaks down, the body wastes, and death may result. Possessing a powerful and peculiar action like this, these medicinal agents fully deserve the name of alteratives, and any method of treatment which may be founded upon their action is incomplete unless it include abundant feeding and fresh air.

Opposed to the alteratives are an important class of drugs which **diminish metabolism.** Alcohol has this action, apparently by being itself so readily oxydised in the tissues that it robs the cells, as it were, of oxygen, while it also binds the oxygen more firmly to the red corpuscles, and thus in two different ways spares tissue change. Quinine also lowers oxygenation, and has a further influence in preventing oxydation of protoplasm, which is imperfectly understood. Probably

Alcohol, Quinine, Antipyrine, Kairin, Chinolin, and Salicin, also diminish the activity of the natural metabolic ferments.

Complex Measures.—Some of the most powerful means at our disposal for influencing nutrition are a combination of the preceding measures. The best illustration of this is the treatment carried on at a foreign bath, we shall say at Aix-les-Bains, in Savoy. Here an English patient enters a new, a purer, and a warmer atmosphere. His food is reduced in quantity and changed in quality; he has to take active muscular exercise; he enjoys a daily bath, which is really a complex arrangement of washing, rubbing, douching, and frequent change of surface temperature; and he has to drink a definite amount of the waters, which contain Soda, Lime, Magnesia, Iron, and Iodine. Such a combination of measures is manifestly powerfully alterative.

Tonics, which increase the tone or general muscular and nutritive vigour, belong, as we have seen, to several of the preceding classes.

III. PATHOLOGICAL RELATIONS.

The disorders of metabolism are many and complex. Diseases so wide apart as gout, syphilis, and malaria, and disorders so different in their cause and effects as fever and fatty degeneration, are linked together by the fact that they are all affections of nutrition. In this place we can refer but to a few of them, and that very briefly.

The cause of metabolic disorder is most frequently found in the *ingesta*. An *excessive* supply of lymph to the active cells, an unnatural richness of the blood in proteids from indulgence in food, or an insufficient supply of oxygen from insufficient exercise, will disturb general metabolism as they disturb hepatic metabolism, and contribute to the production of the diseases known as obesity and gout. *Deficiency* of plasma is a result of anæmia, as we saw in the last chapter; and since it generally accompanies aglobulism and deficiency of oxygen, the result is feebleness of metabolism throughout the entire body. Metabolism is also disturbed by sudden and extreme alterations of *external natural influences*, such as the temperature, moisture, pressure and electrical condition of the air; and local changes of temperature give rise to chills, colds, and rheumatism. The opinion, however, is daily growing that fever and many other disorders of metabolism are often due to the entrance into the tissues of *unnatural, extraneous*, or *infective* substances, whether inorganic, organic, or organised, such as foul air, the contagia of measles, scarlatina, and other exanthemata, and the organisms of malaria, syphilis, and tuberculosis. It is suggested that these organisms interfere with metabolism by settling in the tissues and carrying on an independent metabolism of their own, *i.e.* by living, thriving, and reproducing their like at the expense of the pabulum of the tissues; that they throw the products of their changes into the venous current, which is thus poisoned and infects the rest of the body; and that by their life-changes they cause a development of heat which constitutes one part of fever.

The *phenomena* of disordered metabolism are necessarily of endless variety and complexity. The most striking symptoms attend that kind of excessive nutrition known as *fever*, viz., wasting, increased excretion, high temperature, and general functional derangement. To this subject we shall return in chapter xiv. *Inflammation* may be broadly defined as a similar increase of metabolism in a local form. Defective local nutrition is seen in fatty and calcareous *degenerations*. In some forms of derangement the results are chiefly appreciable in connection with the tissues themselves, as in obesity; in others they are discovered in the excretions, *e.g.* gravel, and glycosuria; in many instances, such as gout, they can be found both in the tissues and excretions. Occasionally they take the form of excessive and unnatural *growth*, invading and destroying the normal structures, as in cancer. In other diseases the growth is rapidly followed by decay, as we see in syphilis and tubercle. When the derangement remains persistently, and establishes itself in the organs, without definite anatomical change, it constitutes in part the so-called *diatheses*—gouty, rheumatic, calculoid, etc. Manifestly in this great collection of diseased conditions we have an urgent demand for treatment.

IV. NATURAL RECOVERY.

Experience has taught us that many of the most common derangements of metabolism, such as fever, gravel, and rheumatism, are of but temporary duration, that is, disappear spontaneously, when the normal conditions have returned or are restored. The forms which natural recovery takes in metabolic disorder are known as *reaction and repair*, *i.e.* increased nutritive activity, often associated with *inflammation*. Unfortunately this class of derangements are peculiarly liable to recur, but this is chiefly because of the return of unhealthy circumstances. Here, too, as elsewhere, recovery is limited by anatomical changes; but even growth and degeneration will sometimes disappear, under favourable conditions.

V. THERAPEUTICS.

The rational treatment of disorders of nutrition is a subject of such large proportions that it can be discussed only in an illustrative way in the present work. A careful consideration, however, of the principles laid down under the preceding heads will, it is hoped, enable the student to extend his knowledge practically on his own account.

The general treatment of disorders of metabolism involves the regulation of the whole manner of living: of the food and air, the work done, the excretions, and, above all, the careful balance of these. Muscular and nervous exercise must be ordered in fair proportion, to prevent obesity and gout on the one hand, or exhaustion and degeneration on the other.

When an actual instance of metabolic disorder demands treatment, we must first attempt to *discover its cause, and to remove it* by the same measures which might have prevented it. Thus the cause of gout may be swept from the system in many instances by a timely and thorough reform of the diet, and stimulation of the bowels, liver, and kidneys by a combined cathartic and cholagogue, followed by a saline, as recommended under the head of the Liver. Lead poisoning may be cured in the same way, by hastening the excretion of the metal by Iodide of Potassium. When these or other disorders of metabolism, such as rheumatism, syphilis, and tuberculosis, have become chronic, great benefit is derived from change of air and treatment by natural baths. We can sometimes remove fatty degeneration, that marked instance of imperfect metabolism, by removing its cause—an imperfect blood-supply, local or general, *e.g.* by Iron. In other cases we may attempt to destroy, if we cannot remove, the cause; thus it is possible (but not certain) that Mercury partly cures syphilis by directly destroying its virus; Quinine malaria; and Salicin rheumatism.

As a rule, however, in the more pronounced, the so-called specific, forms of disordered nutrition, such as tuberculosis, cancer, and syphilis, all that we can do is to *counteract the cause, and relieve or remove its effects;* that is, to treat symptoms. The specific fevers, such as typhoid and scarlatina, must be similarly treated symptomatically, for their course cannot be arrested. The pyrexia is combated by febrifuges or antipyretics, which we shall discuss fully in another chapter; the waste is repaired by nourishment; and other symptoms are relieved as they arise. Inflammation and its effects—abscess, effusions into cavities, growths, adhesions, and so on—will be treated by local stimulants or alteratives, such as poultices; friction with alcoholic, aromatic, and oily preparations; douching, baths, blisters, etc., to which we shall return in chapter xiv.; or they may demand surgical interference. In other kinds of metabolic disorders, such as tuberculosis (phthisis, consumption), we have to direct a considerable part of our treatment to the maintenance of the general nutrition, by preserving digestion, and giving highly-nutritious foods, such as Cod-liver Oil until the process has temporarily spent itself, and ended possibly with the evacuation of the diseased parts.

The question of the treatment of syphilis, chronic gout, rheumatism, and a number of local diseases probably related to these, for example, of the skin, joints, and nervous system, introduces us to the *use of alteratives.* We saw that alterative drugs act by *exercising* the tissues, and we have now to point out how exercise benefits an organ actually the seat of disease. For instance, syphilis is characterised locally by masses or patches of small-celled growths, with peculiar anatomical relations, proceeding probably to ulceration, that is, to death of the part. How do Mercury and Iodine remove these growths and thus cure the syphilis? In answer to this question it may be said that there are two ways in which it may be desirable to exercise tissues. First, there may be need of increased metabolic change in order to remove excessive growth. Mercury and Iodine act, partly at least, in this way upon syphilitic growths. They hasten the life-processes of the young cells so much, that the cells disappear in the form of products, or, as it is commonly expressed, "are absorbed." It is essential to the success of this plan of treatment that the alterative substances should be thoroughly under control, and, as we have seen, that abundant food and air be ingested to prevent failure of nutrition.

Secondly, there is an effect of exercise beyond an increase of work accomplished: work that is increased in *amount* can be changed in *kind;* exercise is beneficial, not only to the indolent individual, but to the vicious. So with the tissues. Exercise may bring them into a new, a normal, state of function, when they have been deranged or even diseased. In order to get the tissues to work normally, we must get them to work *somehow,* knowing that such work means chemical change, or even active nutritive renovation of the elements. The natural disposition which all tissues inherently possess to return to the normal, is thus afforded an opportunity of coming into play; and the result is, not a mere increase of activity, but also an *alteration in kind* of the activity. Henceforth the protoplasm, if supplied with an abundance of food and oxygen, itself returns to the normal state. This powerful effect of alterative drugs is seen in such diseases as chronic gout, skin diseases, rheumatism, and disorders of the nervous system. Besides Iodide of Potassium, the alteratives used for this second purpose are chiefly Arsenic, Silver, Antimony, Phosphorus, and occasionally Copper and

Zinc. Sulphur is a mild alterative, valuable in rheumatism and skin diseases, especially in the form of natural waters. Many vegetable substances are credited with like properties, notably Sarsaparilla, Guaiacum, Hemidesmus, Serpentary, and Mezereum, but the physiological action of these is very obscure, and their value as medicines doubtful.

SYNOPSIS OF DRUGS WHICH INFLUENCE METABOLISM

SUBSTANCES WHICH INCREASE METABOLISM. ALTERATIVES.	SUBSTANCES WHICH DIMINISH METABOLISM.	LOCAL STIMULANTS. LOCAL ALTERATIVES.
Hydrargyrum	Oleum Morrhuæ	Cadmium
Ferrum	Oleum Olivæ	Iodum
Antimonium	Glycerinum	Sulphur
Phosphorus	Alcohol	Water
Arsenicum	Quinina	Fixed Oils
Sulphur	Antipyrine	Alcohol
Calcii Sulphidum	Resorcin	Æther
Calcii Chloridum	Chinolin	Chloroformum
Calcii Hypophosphis	Kairin	Ammonia
Sodii Hypophosphis		Volatile Oils
Water		Oleo-Resins
Guaiacum		Resins
Hemidesmus		Balsams
Mezereum		
Sarsa		
Caffeina		
Guarana		
Coca		
Acidum Salicylicum		

CHAPTER X.

THE CIRCULATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE function of the heart is to drive a certain amount of blood through the whole length of the circulatory system within a given time. In its flow through the small arteries and capillaries, the blood meets with great peripheral resistance, and is dammed back, as it were, upon the larger arteries, which by virtue of the elasticity of their coats are constantly distended, and exert an equal and opposite pressure on the blood. The intermittent action of the heart is thus converted into a continuous force, *the arterial blood pressure*, which (thanks to the aortic valves) urges the blood forwards in a steady stream.

The surface of the blood-stream is broken only in the arteries by the wave raised by each fresh discharge from the heart, and this wave is called *the pulse*.

The *heart* performs its work by virtue of being a nervo-muscular organ, freely supplied with blood by the coronaries. The muscular tissue is normally stimulated to contract by the intra-cardiac ganglia, which, whilst automatic in action, are excited by impressions coming from the inner surface of the heart—chiefly impressions of pressure or resistance; and the vigour of systole is in direct proportion to this pressure, which in turn is referable, partly to the auricular charge, but chiefly to the resistance ahead. The movements of the heart are regulated by the cardiac centre in the medulla, which is that part of the nervous system where afferent impressions are first received, and then reflected as motor impulses to the heart, either by the vagus or by the sympathetic, the *terminations* of which are connected with the cardiac ganglia. An impression made upon the terminations of the vagus diminishes the frequency of the nervous discharges from the ganglia, that is, *inhibits* the contractions of the heart; an impression made on the terminations of the sympathetic accelerates them. With regard to the heart- or pulse-rate, it is highly important to observe that the *length of systole varies very little*; whatever the work to be done, the ventricle takes about $\frac{4}{10}''$ to contract. The part of the cardiac revolution that varies in length is the diastole, which is sometimes long, giving an infrequent pulse-rate, say 50, sometimes short, giving a frequent pulse-rate, say 100. Now, during diastole the nervo-muscular apparatus rests and is nourished, and the ventricles are filled from the auricles and veins. An infrequent pulse is thus (to a certain extent) an indication that the heart is being rested and filling well, whilst the force of the systole is not weakened, probably the reverse, by these two effects. Agencies which thus affect the rate of the heart through the terminations of the vagus and sympathetic, either reach them through the coronary blood, such as drugs, or are transmitted from the central nervous system through the nerve-trunks. Central impulses affecting the *force* of the heart probably reach it through the same channels.

The *cardiac centre* in the medulla is the centre of an area of impressionable matter, which is as extensive as the nervous system itself. Into this centre there pour constant streams of impressions from the vessels, abdominal viscera, skin, muscles, central nervous system (including the seat of mind), from the lungs, and indeed from every organ, including the heart itself; and thence the resulting impulses descend through the vagus and sympathetic to the heart, which is thus subject to every influence, however slight, to which the body may be exposed. Further, the cardiac centre is affected by its blood-supply, including both the quality and pressure of the blood within it.

Amongst the afferent impressions reaching the cardiac centre, those from the heart itself travel through the vagus. These are partly impressions of common sensibility, which pass through the medulla into the convolutions; and although normally too feeble to be perceived, may, if powerful, give rise to sensations of pain, distress, weight, and palpitation, referred to the præcordium.

The *arteries* are active, irritable muscular tubes, whose calibre can be modified by a variety of influences. A local nervous mechanism guides the vasor muscles; vaso-motor and vaso-dilator nerves pass between the local mechanism and the central nervous system; and there is a great central point in the medulla oblongata, called the *vaso-motor centre*, as well as other lower centres in the cord and brain, which collect impressions from every part of the body, and reflect them through the vaso-motor or vaso-dilator nerves, as the case may be, to the vessels. The muscular coat of the arteries, being constantly exercised to a degree, gives so-called "tone" to the vessels, which is one of the elements of that cardinal factor of the circulation, *the peripheral resistance.* The more active the vaso-motor nerves or centres, the greater the resistance and the higher the blood pressure; the more active the dilators, the lower the pressure; and the influence of each upon the heart respectively corresponds. Particular vascular areas, *e.g.* those of the skin and mesentery, may also be dilated or constricted independently of others. Manifestly local dilatation will admit more blood to the part, and so lower the general arterial pressure; local constriction will increase the local resistance, and so raise the general pressure. Amongst the impressions which influence the vaso-motor centre are mental states, visceral conditions, surface temperature and sensations of all kinds. It is also stimulated by deficiency of blood within itself, and by poverty of the blood in oxygen; and drugs act directly upon it as we shall presently see.

The afferent impressions which reach the vaso-motor centre from the heart are so important to the therapeutist that they demand special mention. When impressions originating in over-distension, distress, or failure of the heart, reach the cardiac centre through the vagus, they are transferred to the vasor centre, whence they are reflected to the vessels through the dilator nerves. The vessels are thus relaxed; the arterial pressure, which the ventricle has to overcome, falls; the heart empties itself more readily, and is relieved. This arrangement for reducing the intercardiac pressure is called the *depressor mechanism of the circulation.*

The *capillaries* effect the final distribution of blood to the tissues. Their soft protoplasmic walls, through which the plasma, the oxygen, and the corpuscles pass into the tissues, have irritability of their own, and they are subject to many other influences, viz. those of the nervous system, of the blood which they contain, of the arteries and the veins at either extremity, and of the activity of nutrition. In the capillaries we discover the other element of the *peripheral resistance.*

The *veins* convey the blood back to the heart as comparatively passive tubes. They are probably subject to special nervous influences, but they are chiefly influenced physically by the volume of blood passing through them, that is, by the condition of the heart in front and of the arteries and capillaries behind. Thus, shortness of diastole, *i.e.* frequency of the heart, diminishes the time of emptying the veins, and raises the pressure within them. A low arterial pressure and a free flow through the capillaries have the same effect. Conversely, the veins react physically on the heart and capillaries; if they are dilated and full, the return of the blood to the auricle is delayed, and the force of systole weakened from lowness of the charge, whilst the capillaries are obstructed, and the flow of the plasma and metabolic products between the vessels and the tissues disturbed.

We can now understand the meaning of the expression, *the general blood-pressure.* The elasticity of the arteries being taken as constant, the pressure of blood within the arterial system at any given moment will depend upon (1) the total quantity of blood in circulation; (2) the action of the heart; (3) the freedom of the flow into the veins, *i.e.* the peripheral resistance, due to vasor constriction and capillary obstruction. The arterial pressure is so far self-regulated, through the quantity of blood in circulation, by means of the Malpighian bodies of the kidney. In this mechanism, the general arterial pressure is brought to bear upon a length of unsupported arteriole, so as to press or excrete the water of the blood through the vascular wall into the uriniferous tubule. By the muscular and nervous structures in the walls of the afferent and efferent arterioles, the pressure upon the glomerulus may be cut off, or thrown on, as the system requires, the result being less or more watery excretion, and corresponding rise or fall of the blood pressure. The perspiratory excretion, and, indeed, all excretions, probably act in the same way as the urinary, only less powerfully.

Another powerful influence on the circulation as a whole is muscular activity, exertion being attended by cardiac excitement and high arterial pressure, and muscular rest by calm action of the heart and a quiet pulse.

II. PHARMACODYNAMICS.

The circulatory system affords one of the most striking instances in the body of provisions for physiological change, and of functional reaction to influences of every kind which bear, or may be brought to bear, upon it. Herein lie at once its power of accommodation to circumstances and its vulnerability; and here, too, the therapeutist discovers his opportunity of influencing the heart and vessels at his pleasure.

1. The *total volume of blood in circulation* being one of the prime factors of the blood pressure, every change in this volume, whether by abstraction or addition, must alter the pressure. This can readily be accomplished by leeching, cupping or *venesection* on the one hand, or by *transfusion* on the other hand. As a matter of fact, however, the effect of either method on the circulation is but temporary. The tension of the pulse falls with venesection, only to be raised again by increased absorption of fluids from the tissue and bowels into the circulation. Transfusion raises the blood pressure for a time, but the compensating mechanisms soon restore the previous average pressure. Venesection is therefore the most powerful of all measures for quickly taking the tension off the whole circulation, and relieving the heart and lungs, but it is practically useless for the purpose of permanently reducing the blood pressure; and transfusion is similarly of inestimable value in rapidly restoring the pressure, if it have fallen dangerously low from loss of blood, and thus preventing death by circulatory failure.

2. *The heart.—a. The intrinsic nervo-muscular apparatus* may be either *stimulated* or *depressed*. The first direct cardiac *stimulant* is an active coronary circulation, through which the heart responds to improved quality of the blood in oxygen and plasma, and thus, indirectly, to proper air and food, healthy digestion, and hepatic action. Direct cardiac stimulants include many drugs, such as Alcohol, Digitalis, Scilla, Strychnina, Ammonia, Ether, etc. The continuous battery current applied through the region of the heart acts similarly. *Reflex* stimulation is a ready and powerful means of increasing the activity of the heart, or of rousing it in actual arrest, and includes the various methods of local nervous stimulation described in chapter xi., especially irritation of the fifth nerve by Ammonia, the cold douche and flagellation, and counter-irritation of the præcordium. Cupping and leeching also exert a stimulant influence on the heart through the nervous system, as well as relieving it by abstraction of blood. Carminatives stimulate

the heart, partly directly, partly by reflexion through the central nervous system of their impression on the gastric mucosa. *The mind* is a powerful instrument for invigorating the heart. Cheerfulness and encouragement may be more useful to a patient than many drugs. Lastly, all measures which lengthen the diastole (slow the heart) increase the cardiac strength by affording more time for rest.

The intrinsic nervo-muscular apparatus may be *depressed* or *soothed* by the opposite set of measures: by a low coronary pressure, the effect of low diet, purgatives, diuretics, and diaphoretics; by arresting reflex impulses by means of general, peripheral, and central nervous sedatives, such as Opium, warmth, or plasters applied to the præcordium, and the general warm bath; and by all measures which shorten the diastole, *i.e.*, increase the rate of the pulse. Lastly, we have a number of drugs which are direct cardiac depressants, including Opium, Diluted Hydrocyanic Acid, Aconite, Antimony, Potash, Chloroform, Chloral, Ergot, Veratrine, Ipecacuanha and many more.

The *afferent nerves of the heart*, which carry to the brain the impressions of common sensibility originating in the cardiac tissues, may be depressed by means of Opium, Chloral, Belladonna and its allies, and possibly by heat and cold.

b. The terminations of the vagus in the heart may be *stimulated*, and the cardiac action rendered less frequent, by Digitalis and Scilla. The same part of the inhibitory mechanism may be *depressed*, and the rate of the heat increased, by Belladonna, Hyoscyamus, Stramonium, Amyl Nitrite, and large doses of many drugs. These local measures act very powerfully.

c. The *cardiac centre* in the medulla is readily *stimulated* by certain drugs, such as Digitalis and Scilla, Ether, Alcohol and Chloroform at first, Strychnia, and Belladonna; and by many peripheral nervous impressions, such as counter-irritation and cold. On the other hand it can be *depressed* by warm applications to the surface, such as the hot bath, and by certain drugs, including Chloroform and Alcohol after the first stage, Aconite, Antimony, Opium, Chloral, Diluted Hydrocyanic Acid, Ipecacuanha, Nitrite of Amyl, Physostigma, and Conium. Our control of the inhibitory action of the vagus at either extremity, that is, of the frequency of the heart, is of much value from the power which it affords us of influencing the cardiac nutrition and strength, by lengthening or shortening the diastole or resting-time of the ventricle. Thus it will be found that all cardiac retarders are cardiac stimulants, whilst all cardiac accelerators prove in the end to be cardiac depressants.

In this connection muscular *exercise* and *rest* must be mentioned as the most powerful and available of all the measures which increase and diminish, respectively, the work and nutritive activity of the heart. Rest in bed, avoidance of walking, carriage exercise, movement on level ground, are a descending series of means of giving the heart rest; and the different kinds of wholesome muscular exercise are equally valuable means of throwing work upon the heart, when its condition demands increased activity.

3. *The Arteries.*—The peripheral resistance in the arteries introduces us to a vast number of pharmacodynamical influences which we must be content simply to enumerate:

a. The vaso-motor centre can be *stimulated* directly by Alcohol and Chloroform (temporarily), by Ether, Ammonia, Strychnia, Digitalis, and Scilla; by irritation of the sensory nerves in any accessible part of the body—for instance, by cold, counter-irritants such as mustard, etc., applied to the calves or soles, by stimulation of the trigeminus, the most ready and powerful means of which is Ammonia held to the nose. On the other hand, the vaso-motor centre may be directly *depressed* by Alcohol and Chloroform in the second stage, by Opium, Chloral, Diluted Hydrocyanic Acid, Antimony, Ipecacuanha, Aconite, Belladonna and its allies; by muscular rest; by emotional quiet and balance; and by local sedatives, such as anodynes, warmth, and gentle friction.

b. The local vaso-constrictor mechanism in the arterial walls is stimulated directly by Lead and Silver, Digitalis and Squill, in the first stage, Ergot; and by local cold, produced by irrigation with water, by Ether spray, or by evaporation of spirituous, acid, and saline solutions, such as lotions of Rectified Spirit, Vinegar, and Chloride of Ammonium. We call these measures **vascular astringents.**

Vascular *dilatation* may be effected through the same local mechanism by the Nitrites of Amyl and Sodium, Nitroglycerine, Alcohol, and Belladonna; by the local heat afforded by poultices and fomentations; by the whole group of Volatile Oils, of which Turpentine and Camphor are the types; by Acrid Oils, including Mustard and Mezereon; by irritant metals and metalloids, such as Zinc, Copper, and Iodine; and artificial carbon compounds, including Creasote, Carbolic Acid and their allies. Local vascular dilators are naturally **local circulatory stimulants.** The continuous current also causes local vascular dilatation.

4. *The Capillaries.*—As one of the causes of peripheral resistance, the condition of the capillary areas is an object of great interest to the therapeutist. We can *dilate* the capillaries and increase the flow through them by either local warmth or persistent cold, by friction, and by local nervous irritants, such as the confined vapour of Spirits, Mustard, Aromatic Oils, and other rubefacients. This is but an early stage of the process of in-

flammation, characterised by capillary dilatation and escape of the constituents of the blood, which can be induced by a continuation of the same measures, or by excessive heat, Cantharides, Croton Oil, etc. (vesicants and pustulants), and markedly modifies, as we shall see in chapter xiv., the capillary circulation of neighbouring parts, and the general blood pressure.

On the other hand, we can *contract* the capillaries and diminish the flow through them by the application of excessive local cold (congelation and refrigeration), by Lead, and Silver, which are pure astringents; and by the **constringents**, namely, Tannic and Gallic Acids, and the many vegetables which contain them (Kino, Catechu, etc.), which constringe or "tan" the connective tissues supporting the delicate capillaries, by condensing their gelatinous and albuminous constituents. Some substances, such as Persalts of Iron, may also arrest the circulation in the capillaries by promoting coagulation of the blood within them.

5. Our influence upon the walls of the *veins* appears to be but small. The veins of a part may be dilated by hot applications; contracted, and then dilated, by moderate local cold. Ergot is believed by some authorities to relax the venous walls. Indirect measures are more powerful in our hands. The heart *a fronte*, or the arterial pressure *a tergo*, may be employed, as we have seen, to increase or diminish the venous pressure. The processes of secretion and excretion are not less powerful in modifying the fulness of the veins. Thus, hydragogue purgatives, as we have seen, drain the portal system; and we shall afterwards find that saline diuretics relieve the renal veins in a very similar way.

III. PATHOLOGICAL RELATIONS.

The complex circulatory apparatus is subject to many forms of derangement and disease, a few only of which require to be noticed for the purpose of illustrating the application of drugs and other therapeutical measures.

1. *Disorders* of the heart and vessels belong chiefly to three classes, according to their causes: (*a*) They may be due to direct *nervous* causes, such as mental excitement or depression, or to some cause acting reflexly through the nervous centres in the medulla, such as derangement of the stomach, intestines, uterus, etc. (*b*) They may originate in morbid states of the *blood*, especially anæmia, which disturbs the centres in the medulla, the vessels, and the nervo-muscular structures in the heart. Or (*c*) they may be traced to a *poison* in the system, *e.g.* tobacco, tea, alcohol, lead, and the poison of gout, each of which has a specific action on some part of the mechanism.

2. *Organic disease* will be sufficiently illustrated by a well-marked case of progressive heart disease from some morbid state of the aortic valves. These valves, from their position and constant movement, are peculiarly subject to disease. They thus become distorted or even destroyed, and rendered unfit to direct the movements of the blood, which is consequently obstructed in its exit from the heart in systole, and regurgitates from the aorta during diastole. The great power of adaptation to change of circumstances possessed by the circulation is generally sufficient to *compensate* for moderate valvular disease, by hypertrophy of the muscular walls of the heart. The serious symptoms set in *when compensation fails, i.e.* as a rule, when the nutrition of the ventricular wall is insufficient to supply the increased—possibly ever-increasing—demand for muscular force. Tho order of events is then as follows: systole fails to overcome the intraventricular pressure; the chamber is imperfectly emptied, and therefore over-distended in diastole; the walls are stretched; and the cavity is *dilated.* Pain and "oppression" make their appearance at this stage, and cause great distress. Henceforth derangement proceeds apace. With the dilatation of the chamber, the mitral valve becomes incompetent or misfitting; blood regurgitates in systole into the left auricle; the pulmonary circulation becomes over-distended; the obstruction makes itself felt in the right ventricle; and, after a time, in the right auricle, by forcing the tricuspid. The systemic veins now become congested from obstruction *a fronte;* the viscera become loaded with venous blood; their functions are disordered; and hæmorrhage, dropsy, fluxes of plasma from the bowels and bronchi, and discharges of albumen in the urine occur. These derangements, coupled with those of respiration, the cardiac distress, and the effects of anæmia from imperfect arterial supply, finally render life impossible. During this process of backward dilatation, the cardiac action is necessarily disordered in all respects, the strength and regularity of the pulse giving way, and its rate being decidedly accelerated.

3. *Hæmorrhage.*—Bleeding produces certain effects on the system, partly referable to loss of blood, and partly to fall of the blood pressure. It is naturally arrested by this fall of pressure, by coagulation of the blood at the seat of disease, and by retraction of part of the coats of the vessel. If the hæmorrhage be severe, fainting or *syncope* occurs, that is, loss of consciousness from failure of the heart and consequent deficiency of blood and blood pressure in tho brain. Any other cause of cardiac failure will produce the same effect. At the same time, the weight of the body cannot be supported on account of

the general muscular paralysis, which is another result of the cerebral anæmia; and the patient falls. The recumbency fortunately has a favourable effect: it restores the circulation through the cardiac and vaso-motor centres, increasing their activity; and renders the cerebral centres more responsive to afferent impressions.

IV. NATURAL RECOVERY.

The whole circulatory system is furnished with so many and so accurate regulating and compensating mechanisms, that not only the great range of normal conditions to which it is exposed, but even many morbid changes, can be successfully met. The chief of these provisions for preventing or counteracting disease are the reserve force of the heart; the power of compensatory hypertrophy; the depressor mechanism; the arrangements for relief of the vessels by escape of the fluid portions of the blood through the kidneys and bowels, and into serous spaces; and the natural mode of recovery from hæmorrhage and syncope. All these methods of natural relief or recovery are full of suggestions to the therapeutist, and rational treatment must follow nature's lines. The two circumstances which chiefly set a limit to compensation are failure of the coronary arteries to supply the hypertrophied walls, and suddenness of the cardiac lesion, which may hopelessly disturb the circulation before there is time for hypertrophy to occur.

V. THERAPEUTICS.

Although the details contained in the four preceding sections are very numerous and complex, the rational therapeutics of the diseases of the heart and vessels can be sufficiently illustrated by a few simple principles. The grand fact that stands out prominently amongst all the others is that dilatation must be prevented or relieved. It is a purely physical effect or state, resulting from the failure of the great physiological condition on which alone the circulation can be and is carried on, namely, that the driving power must always be greater than the resistance; *i.e.* whilst it varies with it, it must never fall below it. There are many other indications for treatment, but none that approach this in importance.

The general treatment of disorder and disease of the heart will mainly consist in ensuring an equable manner of life. Extraordinary influences of every kind, bodily and mental, especially exertion and excitement, must be shunned by persons suffering from cardiac disease, or in whom any of its common causes may be at work. When disease attacks the valves (endocarditis), *e.g.* in acute rheumatism, absolute bodily rest is essential, to diminish the strain on them, and the frequency of their movements; and cardiac depressants, such as Potassium, Aconite, and Veratrine, are employed to assist this effect.

Removal of the cause is rarely practicable in heart disease. The opposite is the case in cardiac disorder. Treatment here consists in relieving dyspepsia, in restoring the condition of the blood, in securing mental rest, and in removing all poisons from the system, such as alcohol, tea, and tobacco, by a reformation of diet and personal habits. Carminatives are specially valuable in dyspepsia with palpitation.

A great part of the treatment of diseases of the heart consists in *counteracting the cause*; that is, in *the prevention and removal of dilatation.* The first rational step to be taken is to lighten the load upon the heart, to lower the intra-ventricular pressure which it is unable to overcome. Rest, bodily and mental, is the most obvious and easy means of doing so, the patient being kept in bed, and every kind of exertion and excitement forbidden. The pressure may be further reduced by purgation, which diverts and drains the blood; or, if the condition be urgent, blood must be removed by leeching, cupping, or venesection, all of which may give great relief, or even preserve life when it is threatened. In another class of cases, the arterial tension may be lowered by means of drugs. Nitrite of Amyl acts very swiftly in this way, giving relief in that terrible form of acute distension of the heart which is called "angina pectoris," by instantly relaxing the vessels in front, as well as by accelerating the cardiac action. The same effect may be more slowly produced by the alkaline Nitrites, Potash salts, and Belladonna.

The second means of treating dilatation is by *increasing the cardiac power by direct cardiac stimulants*, such as Digitalis, Scilla, Alcohol, and Ammonia. Mustard or other rubefacients applied to the præcordium are *indirect* cardiac stimulants of great value in some cases. At the same time, the quantity and quality of the blood supplied through the coronaries to the cardiac walls must be sustained by nutritious food, and possibly by Iron: a system which demands, in turn, the strictest attention to the action of the stomach, bowels, and liver, flatulence and other digestive disturbances being highly dangerous to a weak heart.

The third means of treating dilatation is by *increasing the time of cardiac rest.* Three powerful direct cardiac stimulants, Digitalis, Scilla, and Convallaria, have the additional action of stimulating the inhibitory apparatus, both in the heart and medulla. They increase the force of the systole, thus thoroughly emptying the chamber, and preventing over-distension; they lengthen the time of filling the heart, that is, of emptying the veins, thus favouring the venous flow; they afford rest to the heart; and they also increase the arterial pressure, not only by filling the aorta better, but by stimulating the vaso-motor nerves. They are therefore indicated in that backward dilatation of chamber after chamber, ending in dropsy and visceral congestion, which we have discussed, and as a matter of fact they prove of the very greatest value in practice.

Removal of effects: Treatment of symptoms.—Cardiac pain, oppression, anxiety, and other forms of distress, can be relieved by cardiac sedatives, such as local heat or cold, Opium, Chloral and Belladonna. Of these, Opium is the most powerful, and of the greatest value. We must never forget, however, that in Opium we are administering a dangerous cardiac depressant, which paralyses in large doses every part of the circulatory apparatus; and the same remark applies to Chloral. The perfection of the therapeutic art is to use these remedies with judgment. The hypodermic injection of Morphia sometimes gives complete relief. Belladonna is a cardiac anodyne much more easily employed, because less depressant; but is much less efficacious. It is frequently applied locally to the præcordium as the Emplastrum. A rubefacient effect on the chest or the application of leeches will quickly relieve cardiac pain. Pulmonary distress from congestion of the bronchi and alveoli may be specially relieved by stimulant expectorants, such as Ammonia and Scilla, which increase and remove the bronchial flux; but here again the value of rational treatment is seen in the disappearance of dyspnœa, hæmoptysis, cough, and the physical signs of pulmonary engorgement, under the influence of purely cardiac remedies, such as Digitalis and Alcohol. Dropsy may be immediately relieved by puncture of the part, but like other symptoms disappears rapidly by the veins when the cardiac strength is restored. The same remarks apply to the visceral congestions and their temporary relief by purgatives. Diuretics are of great service in cardiac dropsy, acting partly by relieving the renal veins (salines), but chiefly by raising the arterial pressure (Digitalis and Scilla), as is fully discussed under the head of The Kidney in chapter xii.

Hæmorrhage — Hæmostatics. — External hæmorrhage is readily arrested by surgical means. If the lesion be internal, as in the stomach or lungs, we must trust chiefly to medicinal remedies which are known as **hæmostatics.**

(*a*) So far the *cardiac depression* caused by the hæmorrhage may be cautiously encouraged. In every case it is desirable to employ all available means of reducing the force, not the power of the heart, especially bodily and mental rest; and for this purpose general sedatives—Opium especially—are valuable adjuvants to the more direct measures.

(*b*) It is also desirable to take the pressure of the circulation off the bleeding point by *dilatation of a vascular area* in the neighbourhood, and in anastomotic connection; or by inducing a watery flux from it. Thus we employ purgatives in hæmorrhage from the stomach, due to portal congestion, in hæmoptysis or bleeding from the respiratory passages, and in cerebral hæmorrhage, so as to dilate the mesenteric vessels and produce a hydragogue action on the bowels.

(*c*) The *local* measures employed for hæmorrhage are variously known as **local hæmostatics, styptics**, or local vascular astringents. They are imitations or adjuvants of the natural means just analysed, and belong to three distinct classes, according as they act upon, (1) the *blood*, (2) *the vessel walls*, or (3), the *perivascular tissues.*

(1) Hæmostatics may act upon the *blood*, hastening coagulation or precipitating albumen, and thus stopping the bleeding point. Such are Tannin, and the many vegetable substances containing it—Kino, Rhatany, Catechu, Logwood, Galls, Oak-bark, etc.; Alum, Persalts of Iron, Sulphate of Copper, Acetate of Lead, Nitrate of Silver, and Diluted Mineral Acids. Matico probably acts physically.

(2) The hæmostatics which promote *contraction of the broken vessel* are Nitrate of Silver and Acetate of Lead, both very powerful; Ergot; and local cold.

(3) Substances acting upon *the perivascular tissues* may be made to arrest hæmorrhage by combining with the connective tissues, coagulating or precipitating their albuminous substances, and rendering them more compact than normal, or constringed, so that the bleeding vessels are compressed and closed. Such are: Tannin and its allies just enumerated, Lead, Silver, Copper, Zinc, Persalts of Iron, and Alum.

Syncope.—Syncope demands prompt treatment. Nature suggests the first step: the patient must be laid down, with the head at least as low as the heart, so as to restore the pressure and the blood in the cardiac centre. Every possible means must then be used to restore the suspended action of the heart, including direct and indirect cardiac stimulants. The most available of these internally are Ammonia and Alcohol in the form of spirits, or wine; externally, the application of cold, fresh air, flagellation or flicking with wet towels, ammonia held to the nostrils, and the continuous current to the præcordium. Nitrite of Amyl acts quickly in some cases. If swallowing be impossible, Brandy or Ether must be injected into the rectum, or under the skin.

SUBSTANCES WHICH ACT UPON THE CIRCULATORY SYSTEM.

SUBSTANCES STIMULATING CARDIAC CENTRE.

Digitalis
Scilla
Convallaria
Belladonna (at first)
Stramonium (at first)
Hyoscyamus (at first)
Tabacum (at first)
Alcohol (at first)
Æther (at first)
Chloroformum (briefly)
Veratrina (at first)
Physostigma (briefly)
Opium (briefly)
Ammonia
Strychnina

SUBSTANCES DEPRESSING CARDIAC CENTRE.

Digitalis (at last)
Scilla (at last)
Belladonna (at last)
Stramonium (at last)
Hyoscyamus (at last)
Tabacum (at last)
Alcohol (at last)
Æther (at last)
Chloroformum (at last)
Chloral Hydras
Acidum Hydrocyan. Dil.
Veratrina (at last)
Aconitum
Physostigma (chiefly)
Opium (chiefly)
Antimonium
Ipecacuanha
Conium
Amyl Nitris
Nitrites

SUBSTANCES STIMULATING NERVO-MUSCULAR APPARATUS.

Digitalis (at first)
Scilla (at first)
Camphor (at first)
Strychnina
Alcohol
Æther
Convallaria
Veratrina (at first)
Senega (at first)
Opium (briefly)
Ammonia

SUBSTANCES DEPRESSING NERVO-MUSCULAR APPARATUS.

Antimonium
Bromum
Digitalis (at last)
Scilla (at last)
Camphora (at last)
Belladonna (at last)
Hyoscyamus (at last)
Stramonium (at last)
Lobelia
Arnica (at last)
Tabacum
Alcohol (at last)
Æther (at last)
Chloroformum
Chloral Hydras
Acidum Hydrocyanicum Dil.
Aconitum
Ol. Terebinthinæ (specifically)
Ergota
Veratria (at last)
Colchicum
Senega (at last)
Physostigma (at last)
Opium (chiefly)
Ipecacuanha
Potassium
Lithium
Purgatives
Diuretics
Diaphoretics

SUBSTANCES STIMULATING INHIBITORY APPARATUS.

Digitalis (at first)
Scilla (at first)
Convallaria
Senega (at first)
Belladonna (briefly)
Stramonium ,,
Hyoscyamus ,,
Tabacum (at first)
? Ergota
Opium (briefly)
Plumbum (indirectly)

SUBSTANCES DEPRESSING INHIBITORY APPARATUS.

Amyl Nitris
Nitrite of Sodium
Nitro-glycerinum
Spiritus Ætheris Nitrosi
Digitalis (at last)
Scilla (at last)
Senega (at last)
Belladonna (in ordinary doses)
Stramonium (in ordinary doses)
Hyoscyamus (in ordinary doses)
Tabacum (at last)
Chloral Hydras
Opium (chiefly)

Substances which act upon the Circulatory System (*continued*).

General Vaso-Motor Stimulants.

- Digitalis (at first)
- Scilla (at first)
- Belladonna (briefly)
- Stramonium (briefly)
- Hyoscyamus (briefly)
- Strychnina
- Alcohol (at first)
- Æther (at first)
- Chloroformum (at first)
- Acidum Hydrocy. Dil. (at first)
- Veratrina (at first)
- Ammonia
- Plumbum

General Vaso-Motor Depressants.

- Amyl Nitris
- Nitrite of Sodium
- Nitro-glycerine
- Spiritus Ætheris Nitrosi
- Digitalis (at last)
- Scilla (at last)
- Belladonna (in ordinary doses)
- Stramonium (in ordinary doses)
- Hyoscyamus (in ordinary doses)
- Lobelia
- Tabacum
- Alcohol (at last)
- Æther (at last)
- Chloroformum
- Chloral (central and periph.)
- Acidum Hydrocy. Dil. (at last)
- Veratrina (at last)
- Opium moderately)
- Antimonium
- Ipecacuanha
- Aconitum

Local Circulatory Depressants: Vascular Astringents.

- Alcohol (evaporating)
- Æther ,,
- Chloroformum ,,
- Plumbum
- Argentum
- Digitalis
- Hamamelis
- Constringents

Local Circulatory Stimulants.

- Iodum
- Camphora
- Arnica
- Alcohol (confined)
- Æther (confined)
- Chloral Hydras
- Ol. Terebinth.
- Veratrina
- Sinapis
- Cantharis
- Ammonia
- Metallic Salts
- All Aromatic Volatile Oils, Oleo-resins, Resins, and Balsams.
- Acid. Carbolic.
- Creasotum.

Styptics.

- Matica
- Tannicum Acidum
- Galla
- Quercus
- Krameria
- Catechu
- Hæmatoxylon
- Alumen
- Ferrum

Reflex Cardiac Stimulants.

- Alcohol
- Æther
- Chloroformum
- Sinapis
- Ol. Terebinthinæ (reflex)
- Ammonia
- Carminatives
- Counter-irritants
- Bitters

Reflex Vascular Stimulants.

- Alcohol
- Æther
- Chloroformum
- Sinapis
- Ol. Terebinthinæ (reflex)
- Ammonia
- Carminatives
- Bitters
- Counter-irritants

Substances lowering Blood Pressure in uncertain Manner.

- Ergota
- Physostigma (chiefly)
- Barium

CHAPTER XI.

THE RESPIRATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE *red corpuscle* of the blood is the oxygenating or respiratory element of the body. The physical part of respiration is carried on by means of the chest and respiratory passages, a fresh supply of oxygen being continually presented to the red corpuscles, and carbonic acid, water, and heat given off from the plasma.

The red corpuscle and the chest are brought into functional relation with each other by means of a special nervous mechanism, called the *respiratory centre*, a portion of nervous matter in the medulla oblongata which is peculiarly irritable in the presence of oxygen, and sends motor impulses through the cord to the respiratory muscles.

The less the amount of oxygen admitted to the respiratory centre, the more powerfully is it stimulated, and the chest moved; the greater the amount of oxygen admitted to the centre, the less powerful its discharges, and the more weak or superficial is the breathing. Now the amount of oxygen in the arteries of the medulla is the same as in the systemic arteries generally; and we thus find that the state of oxygenation of the arterial blood governs the respiratory movements through the medium of the respiratory centre. The fundamental canon in the physiology of respiration is that *the condition of the red corpuscle is the prime mover of all respiratory acts.* Carbonic acid has but little direct effect on the respiratory centre.

The term "centre" implies that certain influences meet in this point, originating in a circle of which it is the middle point; and this is the case. Falling into the respiratory centre are impressions conveyed by afferent (usually sensory) nerves, from every part of the body, modifying its activity, and reflexly influencing the respiratory movements. The vagus is peculiarly capable of stimulating the centre; thus irritation of the larynx immediately causes the reflex respiratory act called cough. The vagus is therefore said to be the special afferent nerve of respiration; the whole surface of the respiratory passages, and probably the lungs, being abundantly supplied with rootlets of the vagus, which are incessantly collecting impressions for transmission to the centre. Every change in the distension of the lungs, and in the quantity and quality of the pulmonary blood, thus instantly tells on the respiratory movements. It must also be carefully noted in this connection that diminished oxygenation of the blood, whilst increasing the respiratory activity, stimulates the other two great centres in the medulla, increasing the arterial resistance through the vaso-motor centre, and slowing the heart through the cardiac centre.

The afferent impressions from the lungs and respiratory passages, besides falling into the respiratory centre, also reach, if sufficiently powerful, the convolutions, where they are felt as various *sensations*, referred more or less accurately to the respiratory organs. In health these sensations of common sensibility are feeble; and we do not appreciate them until they are converted into sensations of pain, oppression, distress, or irritation, in disorder or disease.

Amongst the nerves of the respiratory muscles one group demands special notice, viz. those distributed to the bronchi. These are motor filaments of the vagus, which originate in the respiratory centre and supply the muscles regulating the calibre of the air tubes. They bring the bronchi under the control of the medulla, and thus of the afferent impressions, especially of those very impressions which originate in the respiratory passages, the seat of their own distribution.

II. PHARMACODYNAMICS.

The extensive relations of the respiratory organs to the external air, to the blood and circulation, and to the nervous system, afford us abundant means of influencing their mode of action. These means we will now review in their natural physiological order:

1. *The Air.*—The air which comes in contact with the organs of respiration may be altered in five different respects, each of which will have a physiological effect upon the functions of the lungs, viz. as regards (*a*) its *absolute amount*, (*b*) its *chemical composition*, (*c*) its *temperature*, (*d*) its *moisture*, and (*e*) its *pressure.*

(*a*) The supply of air, like that of the food, may be entirely *arrested* for a time, another gas with different physiological properties, such as Nitrous Oxide, being allowed to take its place. Or the amount respired may be simply *reduced*, by administering rarefied air; or *increased*, by admitting oxygen or compressed air into the lungs. The same effects may be produced by ordering little or much muscular exercise respectively.

(*b*) The *chemical composition* of the atmosphere, physiologically speaking, relates only to the amount and quality of the oxygen. The proportion of oxygen to nitrogen in the air may be modified by arrangements for special inhalation, but practically this is seldom attempted, mountain and ocean climates affording us a much more satisfactory supply of pure air.

(*c*) The *temperature* of the air respired may be modified either by selecting particular climates—tropical, sub-tropical, temperate, or cold; by artificial regulation of the atmosphere of the room—ventilation, heating, etc.; or by arrangements for warming or cooling the ingoing current of air only, by means of so-called "respirators," and by recommending nasal breathing only, or oral breathing only, as the case may be.

(*d*) The amount of *moisture* in the air respired can be altered at pleasure, whether by residence in a dry climate or in a moist climate, or by varying the amount of watery vapour in the air of the room, or in the individual inspiratory draughts, by means of steam kettles, hot-water inhalations, etc.

(*e*) Lastly, the *pressure* of the air is completely under our command; and this again either by means of climate (elevated mountain residence), or by local artificial arrangements such as the air-bath and pneumatic apparatus. The *compressed air-bath*, at a pressure of $\frac{1}{5}$ to $\frac{1}{2}$ of an atmosphere above the normal, increases the amount of oxygen admitted into the blood, as well as the vital capacity and the size of the lungs, whilst it renders respiration less frequent and more easy. A rarefied atmosphere is never given as a bath; on elevated mountains it increases the depth and frequency of respiration and the vascularity of the lungs, so that there is a tendency to hæmorrhage from the alveoli. The *pneumatic apparatus*, a small gasometer, admits air under artificial pressure to the respiratory passages only, the patient breathing into, or out of, a valved tube connected therewith. Inspiration of air compressed by about $\frac{1}{60}$ atmosphere increases the amount of air entering the chest, and eventually the vital capacity, the size of the chest, and the respiratory force, whilst it diminishes the vascularity of the lungs and raises the arterial pressure. The other methods of *aërotherapeutics* do not require mention here.

2. *The Red Corpuscle.*—The red corpuscle as the great medium of external and internal respiration, as well as the prime mover of the respiratory centre, is an important agent through which the respiratory activity may be modified by food, drugs, and all the ordinary natural influences, studied in chapter viii.

3. *The Circulation.*—The corpuscles must be circulated by the heart and vessels, and any effect that we may produce upon these will greatly modify the respiratory functions. The pharmacodynamics of the circulation are discussed in the preceding chapter.

4. *The Lungs and Air passages.*—(*a*) *The afferent or sensory nerves* of the respiratory organs are *stimulated* by cold and dry air, Chlorine gas, Ipecacuanha, Senega, Tobacco, Nitre fumes, Ammonia, and Antimony. They are *depressed* or soothed by warm and moist air, warm food, warm applications to the chest wall; possibly by demulcent substances to a small extent; and by Opium, Chloral, Chloroform, and Ether. *Sensations* connected with the respiratory organs may be modified by the same means, the nerve depressants thus proving to be pulmonary anæsthetics or anodynes, as well as interfering with reflex respiratory acts.

(*b*) *The vessels of the bronchi* may have the circulation through them *increased* by all measures which increase the activity of the circulation generally, viz. by purgation, exercise of the lungs, and bodily movement; by Digitalis, Scilla, Ammonia, Alcohol, Strychnine, and probably the whole series of Aromatic Oils to be presently noticed. *Per contra*, the bronchial circulation may be *depressed* by all cardiac and general vascular depressants, including heat, Alkalies, Iodides, Aconite, Antimony, and Ipecacuanha.

(*b'*) *The pulmonary circulation* bears very complex relations to the respiratory movements, as regards the pressure and rate of flow in inspiration and expiration, ordinary and extraordinary. Manifestly as regards the general circulation, the pulmonary vessels may be modified by every influence which affects it, such as blood-letting, transfusion, purgation, a variety of drugs, and muscular rest or exercise. We possess one substance, non-officinal, which specifically contracts the pulmonary vessels, namely Muscarin, the active principle of the mushroom.

(*c*) *Glands of the bronchi.*—The secretion of bronchial mucus may be *increased* by alkalies, especially Ammonia; by Iodine, Sulphur, and Antimony; by Ipecacuanha, Senega, Tobacco, Scilla, and the great group of Aromatic Volatile oils, Oleo-resins, and Balsams, including Turpentine, Camphor, Benzoin, Copaiba, Ammoniacum; and the balsams of Peru and Tolu. Warm liquid food remarkably increases the bronchial secretion; on the contrary, cold dry food *diminishes* the bronchial mucus, as possibly do Belladonna, Stramonium, and Hyoscyamus, and certainly acids.

(*d*) *The nervo-muscular structures* of the bronchi and larynx are *stimulated* by those measures which act upon the afferent nerves (*a*) and perhaps they are also directly influenced by some of the same.

A group of substances of great therapeutical interest directly *depress* the same system, and so relax the bronchial walls and favour the movements of the respiratory air, viz. Belladonna, Stramonium, Hyoscyamus, Lobelia, and Tobacco; Opium, Chloral, and Cannabis Indica; Chloroform, Ether, Amyl-nitrite, and Iodide of Ethyl; Conium, and warm moist air.

5. Impressions reaching the respiratory centre through *other channels than the vagus* afford us a remarkably ready means of affecting it. Impressions may be *stimulating*, including irritation of the fifth cranial nerve in the nose by Ammonia, or on the brow by cold; of the olfactory nerve by odoriferous substances; of the optic and acoustic nerves by powerful light and sounds respectively; and of the nerves of the skin generally by painful impressions, such as flicking with towels, flagellation or slapping, extreme heat, mustard plasters, and other powerful local irritants. Or we may use measures with a *sedative* influence on the respiratory centre, including gentle warmth to the surface of the chest in the form of poultices and fomentations, warm baths, and local anæsthetics or anodynes, such as plasters and liniments of Opium, Belladonna, and Volatile Oils (Turpentine, Camphor, etc.) applied to the chest walls.

6. *The Respiratory Centre.*—Besides those influencing the afferent impressions, a variety of direct stimulants and depressants of this centre are in our possession. The force of the nervous discharges may be *increased* by Ammonia, Strychnine, Belladonna, Stramonium, and Hyoscyamus; probably by Ipecacuanha and Antimony temporarily; and by Alcohol, Ether, and Chloroform, for a brief period at the commencement of their action. On the other hand, the last-named drugs quickly *diminish* the force of the respiratory centre (Ether less rapidly than the others); and the same effect may be produced by means of Chloral, Opium, Aconite, Veratrine, Conium, and Physostigma.

7. *The Tracts of the efferent impulses from the respiratory centre, the Spinal Centres* of the respiratory muscles, and *the Nervo-muscular Apparatus* of the chest and larynx may be *stimulated* not only reflexly, but directly, by Strychnine, which greatly increases the vigour of the spinal centres; by electricity applied to the nerve trunks (phrenics, intercostals), or to the muscles directly; and by all measures which improve the nutrition of the nervo-muscular tissues, such as well-ordered exercise. Conversely, these parts may be *depressed* by Physostigma, which greatly diminishes the vigour of the spinal centres; by Conium, which paralyses the motor nerves; and by Opium, which depresses the whole efferent mechanism. The use of these depressing measures is almost confined to the muscles of the larynx. Most powerful of all is the method of arresting, or at least controlling, the movements of the chest, by direct restraint, which is best accomplished by means of strapping or bandaging.

When we review the various measures classed under the 1st, 4th, 5th, 6th, and 7th preceding heads, we are enabled to re-arrange several of the most important of them into new groups with definite pharmacodynamical properties and important therapeutical bearings. These groups are: (A) *Expectorants;* (B) *Antispasmodics;* and (C) *Respiratory Sedatives.*

A. **Expectorants.**—Expectoration, the discharge of the sputa, or secretions and other products of the respiratory passages, will manifestly vary with the *amount* and *characters* of the sputa, and with the expulsive *force* which can be brought to bear upon them. Measures are therefore called *expectorants* which increase the absolute amount of sputum formed, which so modify its characters as to facilitate its expulsion, or which evacuate it with greater ease: the first and second kinds of expectorants acting upon the glands, the third kind upon the muscular structures. Regarded otherwise, the expectorants will be found sometimes to stimulate the respiratory centre, *e.g.* Ammonia and Ipecacuanha, sometimes to depress it, *e.g.* warm, moist air. But of greatest practical importance is the action of expectorants upon the circulation; and according to their stimulating or depressing influence in this respect, they are commonly divided into (1) *Stimulant expectorants,* and (2) *Sedative expectorants.* It must be clearly understood that "sedative" and "stimulant" in this connection refer *not* to the respiratory, but to the circulatory effect of the bronchial measures.

(*a*) **Stimulant expectorants** include Ammonia, Scilla, all the Volatile Aromatic Oils, Oleo-resins, and Balsams enumerated above; Strychnine, Alcohol, Senega, warm liquid food, and moderate exercise of the body generally or of the chest.

(*b*) **Sedative expectorants** include Alkalies, Iodides, Antimony; Ipecacuanha, and Tobacco; warm, moist air; and warm, moist applications to the chest walls.

If we wished to construct other groups of expectorants we might add:

(*c*) **Expectorants with a sedative effect on nerves.**—These are chiefly obtained by combining other expectorants with Opium, *e.g.* Scilla and Opium, Camphor and Opium, Ammonia and Opium, Ipecacuanha and Opium—all of which combinations are officinal, Antimony and Opium, etc. Warm drinks have the same effect.

(*d*) **Expectorants which alter the chemical composition of the sputa.**—This is a highly important group. Alkalies increase the alkalinity of the sputa, and at the same time the water of the bronchial mucus, and thus the liquidity of the sputa. They constitute a special class called the **Saline expectorants.** Sulphur, Iodine, all the Aromatic Oils, Oleo-resins, and Balsams, are excreted, as such, or as their products, along with an increased flow of mucus; and most of these, especially the aromatic substances, have an antiseptic, deodorant, and disinfectant effect on the secretion, and on the surface from which they are given off. They may be classed as the **Disinfectant expectorants.** The water of the bronchial mucus is increased in almost every instance of increased secretion, but specially by Alkalies, Iodine, and Antimony, which thus possess the valuable property of increasing the liquidity of the sputa. Lastly, Acids tend to diminish the amount of water, and thus the total amount of sputum, *i.e.* to "dry up" the secretion. They may be called **anti-expectorants.**

B. **Anti-spasmodics.**—These comprise a great variety of measures which have the common effect, directly or indirectly, of relaxing the muscular coat of the bronchi and the diaphragm. They are: (*α*) the various depressants of the respiratory branches of the vagus mentioned above (4*a*), such as heat, Iodides, Alkalies, etc. (*β*) The depressants of the other afferent nerves to the respiratory centre (5), especially warm applications to the chest walls. (*γ*) The depressants of the respiratory centre itself (6)—Alcohol, Ether, Chloroform, Opium, etc. (*δ*) The direct nervo-muscular depressants—bronchial (4 *d*), such as Atropia, Tobacco, Amyl-nitrite, etc.; and parietal (7), Conium, etc. All these substances are distinctly depressant or sedative; but we have still another group of bronchial antispasmodics (*ε*), which are perhaps the most powerful of all, viz. some of the expectorants, such as Ipecacuanha, Senega, and Tobacco, which after momentarily increasing the spasm, cause a rapid and profuse flow of mucus from the bronchial wall, thus relieving the fulness of the vessels, provoking cough, and inducing expulsion of the cause of the spasm.

C. **Respiratory sedatives.**—These measures deserve a special name. The depressants of the afferent branches of the vagus to the brain, such as Opium, Ether, Chloroform, etc., not only act as antispasmodics and muscular depressants, *i.e.* prevent bronchial spasm, widen the tubes, and arrest cough, but also prevent or relieve pain and other distressing sensations referred to the respiratory organs. The most rational kind of pulmonary sedatives, however, are the expectorants above enumerated, in cases where the cause of the distress can be removed. A combination of the two classes will manifestly answer best in most instances.

III. PATHOLOGICAL RELATIONS.

The disorders and diseases of this system fall readily into two great classes, according as they affect (1) *the respiratory* *element* (*the red corpuscle*) and *its circulation*, or (2) the *nervo-muscular apparatus*, including the lungs and air passages, the respiratory centre, and the afferent and efferent channels of communication. The first class were discussed in chapters viii. and ix.; the second will now be briefly noticed.

Circulatory, inflammatory, and degenerative changes comprise a large part of the diseases of the respiratory organs, such as bronchitis, pulmonary congestion, emphysema, and pleurisy, to which must be added new growths, whilst tuberculosis and syphilis occupy an intermediate position. Whatever their pathological nature, these diseases produce certain well-marked anatomical changes in the parts. The passages may prove to be obstructed, or actually occluded, by swelling of their mucosa, and by various products, such as mucus, pus, blood, or *débris*, which may be retained, inspissated, or possibly decomposed, thus irritating the nerves and vessels. Some of the bronchia may be entirely blocked, with collapse or consolidation of the corresponding lobules, and disturbance of the air pressure (emphysema) and blood pressure (hyperæmia) in the parts around. Portions of the lungs may be found either consolidated by pneumonia, or compressed by pleurisy, airless and functionless. Tracts of various size are frequently entirely destroyed by phthisis or gangrene. Hæmorrhage may occur in the alveoli or passages. The right heart frequently proves to be secondarily enlarged, from disturbance of the venous circulation; the viscera congested; and the serous cavities and extremities dropsical.

Whilst many of these anatomical changes are fortunately remediable, others are not so, and the efforts of the practitioner can only be directed to the relief of their symptoms, or, more correctly, their effects. Amongst these, disturbances of respiration, spasm, cough, expectoration, vomiting, and pain, alone require to be briefly noticed here.

Dyspnœa is a natural effort to increase oxygenation, and is due to stimulation of the respiratory centre in two distinct ways, viz. (1) by the imperfectly oxygenated blood circulating within it, and (2) by exaggeration of the impressions coming from the air passages and lungs. Obviously these two sets of causes are usually combined, since such anatomical changes as have been mentioned, interfere at the same time with the proper contact of the air and blood in the lungs, and irritate the pulmonary branches of the vagus. As a rule, dyspnœa is effective and highly beneficial; but unfortunately, if it fail to give relief, it tends to aggravate the distress.

Spasmodic dyspnœa, commonly called "asthma," is referable to sudden intermittent irritation of the vagus or centre.

Powerful reflex respiratory impulses are thus generated, and pass out to the bronchial muscles and the diaphragm, which are spasmodically contracted, interfering with the entrance of air.

Cough is essentially a physiological act, in itself highly beneficial, which may require to be encouraged and increased. Much more commonly, however, it is excessive, and becomes one of the most distressing symptoms demanding relief in disease of the chest. *Expectoration* may also be considered physiological within certain limits, but will require to be modified therapeutically when the quantity of the sputa is either excessive or deficient, or the quality rendered morbid by inspissation or decomposition. *Vomiting* is closely associated with cough and expectoration, which is not a remarkable circumstance, the two acts and their mechanisms being nearly allied to each other, as we saw in chapter iv.

Pains, and sensations of irritation, tickling, necessity to cough, "want of breath," tightness, oppression, suffocation, etc., are always exceedingly distressing; and, as they are among the chief complaints of patients, demand relief if it can be afforded.

IV. NATURAL RECOVERY.

Nature's method of meeting an extraordinary or otherwise morbid influence by *destroying* or *removing* it, is well seen in the case of the respiratory system. Coughing and sneezing are provisions for expelling any obstructing or irritating mass from the air passages; and although apparently but of little service in preventing the most serious kinds of lung disease, they may really expel infective and other causes of morbid change much more frequently than we suspect, just as they guard the nose and the glottis from mechanically irritant particles.

The second great natural method of relief which is seen at work in this system is *reaction* or *counter-action.* The respiratory muscles respond to an obstruction in the passages by such an increase of the force and frequency of their contraction as will negative its action, and after a time they become hypertrophied if the obstruction persist. Dyspnœa or (better) hyperpnœa, is the result, a large reserve of muscular force and an almost unlimited power of hypertrophy sufficiently *compensating* for the diminished size of the air passages and air current, by increasing the depth and the frequency of breathing. The same principle is at work in the catarrh, that is the hyperæmia and secretion, set up in the air passages or lungs on the entrance of a foreign body; the mucous, serous, or even purulent discharge (all evidences of different degrees of reaction) being essentially intended to counteract the irritant, as well as to carry it off and repair the damage it may have wrought.

The third natural provision against a morbid influence is the *removal of its effects*, whether the influence itself have been removed or antagonised, or not. Thus excessive secretions or other products of disease, which may in turn cause fresh obstruction of the passages, are removed by cough, expectoration, and vomiting; and the venosity of the blood which they cause is dispelled by hyperpnœa. Even spasm of the bronchi probably never causes death, because removed by the carbonic acid which accumulates in the blood in the second stage of asphyxia. Hæmorrhage from the lungs or nose frequently comes to the relief of over-distended veins, and removes the most urgent symptoms.

Vicarious action is yet another method of natural relief, of which abundant advantage is taken in respiratory disease; extraordinary muscles being called into play in hyperpnœa, the healthy parts of the pulmonary substance taking on increased function, and the skin and kidneys doubtless becoming more active as excretory organs.

In these several ways nature will frequently afford relief of respiratory disorders and diseases, whilst the cause of them is still at work, by removing or counteracting it and its effects. If she fail, and disease is established, recovery may still follow artificial treatment, the proper province of which is thus to assist, not to compel, much less to thwart nature. Even if organic changes have occurred, recovery may be effected by repair, as we see in inflammation of the lungs and pleura.

V. Rational Treatment.

The treatment of respiratory disorders if it is to be thoroughly rational, must be founded upon the considerations given in the four preceding sections. The student will understand that the treatment of the *disease* on which these disorders depend must be conducted at the same time; and that we are here concerned only with symptoms.

Dyspnœa.—The phenomena of dyspnœa strongly indicate the necessity of providing, by every possible means, for increased freedom and force of respiration—of assisting hyperpnœa by admitting as much air as possible into the chest. The air must be pure and mild, that is, abundant, fresh, warm, and moist. The muscles of respiration must be free to act upon the chest, and every available muscle of extraordinary respiration must be relieved from other employment and ready to be called into use: the shoulders must be raised, the chest freed from restraint and weight, in front, behind, and especially below (by adopting the sitting posture), and the arms must be capable of being fixed, if necessary. The circulation also must be spared by absolute rest and other measures.

Medicinal treatment must then be ordered, the first end to be secured being the rapid clearance of the respiratory passages of the products of disease. This is done by stimulating the natural provisions for relief, namely *cough and expectoration*, by means of expectorants. The cough must not only be induced or strengthened, but accompanied by a more profuse flow of watery mucus, so as to facilitate discharge of the sputa. Fortunately, most expectorants produce the second effect as well as the first; and we are left free to select our remedy, more from a consideration of its concomitant effect upon the circulation, *i.e.* according as a *sedative* or a *stimulant* effect is desired. Cardio-vascular sedatives, such as Antimony, Ipecacuanha, Iodides, and Alkalies, or a combination of these, will be preferred as expectorants in the first stage of inflammatory obstruction of the passages (*acute bronchitis*), salines being specially valuable as liquefying the mucus; whilst stimulants, such as Ammonia, Scilla, and the large Aromatic group, will be indicated at a later stage when the heart threatens to fail, or at any period in weak subjects. The Aromatics, such as Camphor, the Balsams of Benzoin, Tolu and Peru, Ammoniacum and Turpentine, also act as disinfectants, if the products have become purulent and tend to decompose. In every instance the value of warm liquid food must be taken advantage of.

Emetics may be employed to empty the respiratory passages when blocked by a comparatively large and solid mass, such as a croupous membrane; to empty dilated bronchial tubes when these and the lung tissue have lost their elasticity from age and debility; and occasionally, when the necessary cough can no longer be induced on account of extreme weakness, and asphyxia is threatening. In the last-named case much danger attends such a depressing method of treatment; and in every instance comparatively mild and yet certain emetics must be selected for respiratory purposes, such as Ipecacuanha and Carbonate of Ammonia, or Sulphate of Zinc if these fail.

Posture is frequently of value in emptying the bronchi, or cavities communicating with them, of pus and other products. The body may sometimes be even inverted with success.

If asphyxia occur, artificial respiration must be carried out.

Dyspnœa may also be relieved by the abstraction of blood, or by its diversion from the thorax into the abdominal vessels, where its volume can be reduced by a free purge. This sometimes affords great relief at the commencement of acute bronchitis. Diaphoretics and diuretics are valuable under similar circumstances. But instead of reducing the volume of blood, or in addition to this means, we may prevent its accumulation in the lungs and right side of the heart by stimulant measures. Thus Carbonate of Ammonium not only stimulates the nerves and glands of the bronchial mucosa, liquefies the secretion, and strengthens the respiratory centre, but is a powerful cardio-vascular stimulant, aiding the ventricular contractions, emptying the veins, and filling the arteries. Other circulatory stimulants which may not possess expectorant action are so far also indicated in respiratory distress, such as applications of mustard to the chest-wall and warm alcoholic drinks.

In dyspnœa from consolidation of the lung in acute pneumonia, *i.e.* from *diminished respiratory area*, the plan of treatment must be considerably modified. Here there is neither lack of air nor lack of blood; only they cannot come into mutual contact. The respiratory rate is greatly accelerated, and the air thus constantly changed; the cardiac rhythm is also accelerated, and the blood thus constantly renewed. The therapeutist appreciates this natural provision, and directs his measures to the support of the powers thus severely taxed: to maintain the strength of the respiratory muscles, and, most anxiously of all, to sustain the heart, by failure of which death is most likely to occur. Whilst, therefore, the strength is spared in every way, food is to be freely given with Alcohol, Scilla, Ammonia, and Digitalis; the atmosphere maintained as pure and fresh as possible; and the accompanying fever, which is attended by cardiac depression, steadily combated by suitable non-depressing measures.

Dyspnœa with spasm is so far to be treated on the same principles as other forms of obstructive dyspnœa, but the spasmodic element must be separately considered. Practically, by far the most rapid and powerful antispasmodics are, as we have seen, certain *expectorants*, including Tobacco, Ipecacuanha, etc., which provoke greater spasm, violent cough, and profuse watery secretion, thus instantly clearing the passages and relaxing the mucous membrane. A milder and equally rational class of antispasmodics to be employed in asthma are the direct depressants of the nervo-muscular structures of the bronchi, the chief of which are Belladonna, Hyoscyamus, Stramonium and their Alkaloids, Tobacco, and Lobelia, whether in solution or in the form of smoke. Conium is much less useful. Moist warm air or steam may be of great service as the only available remedy. Opium, Chloral, Cannabis Indica, and other narcotics, will frequently relieve spasm, but such powerful respiratory depressants are highly objectionable in threatening asphyxia. Nitrite of Amyl may instantly give relief, but the spasm may as quickly return; Nitre fumes suit some cases. Small doses of Spirit of Ether or Chloroform in solution are frequently most valuable, because so rapidly diffusible; and a mixture of Ammonia, Carbonate of Ammonium, Spirit of Ether, and Aromatics is one of the best combinations for general use.

Cough has been already referred to as far as it is to be encouraged, for the relief of movable obstruction and dyspnœa. When it is not only ineffectual but harmful, for instance when due to swelling, morbid growths, or purely nervous causes, it demands immediate relief. It cannot, however, be too much insisted on that the tendency of young practitioners is towards an abuse of this class of remedies, by prescribing them in a routine fashion for every case of cough, irrespective of its cause. Narcotics are powerful depressants of the respiratory centre, as well as of many other organs, including the heart; and, which is of equal consequence, they interfere with the reflection which originates useful cough and increased breathing, and ultimately aggravate the condition which they temporarily relieve. It is only when the cause of cough cannot be removed, that the irritability of the nervo-muscular apparatus may be safely reduced by respiratory sedatives, such as Opium, Chloroform, Ether and Chloral, Alcohol and Conium, according to circumstances, although warm moist air, warm liquid food, poultices to the chest, and acids or demulcents for the throat will often suffice to give relief. Several of these measures may be topically employed by insufflation, inhalation, gargling, or direct application; and when given internally they are advantageously combined with expectorants, which shall remove any movable irritant from the passages. When all but powerful opiates have failed to arrest protracted fits of coughing, as in phthisis, frequent small meals of warm liquid nutritious food, night as well as day, or pure alcoholic stimulants, will often give great relief. When the sputa are excessive, anti-expectorant measures may be demanded, and will consist in a fresh bracing atmosphere, dry simple food, the avoidance of alcohol, and the exhibition of Acids, Bitters, and probably Iron internally.

Hæmorrhage from the respiratory organs must be treated on general principles. Rest must be secured not only by bodily quiet, but by the reduction of the movements of the lungs to a minimum, by strapping the chest locally and recommending voluntary restraint of respiration and cough.

Pain and the other forms of *distress* in connection with this system are easily arrested by direct respiratory sedatives, such as Opium, but, as we have seen, not without considerable risk. The greatest discrimination must, therefore, be exercised in having recourse to these remedies, and the routine use of them is to be deprecated. Indirect measures, including the removal of the cause of distress, and external applications to the chest, are alone to be employed if possible.

SUBSTANCES WHICH ACT UPON THE RESPIRATORY SYSTEM.

Stimulants of Respiratory Centre.	Stimulant (Circulatory) Expectorants.	Antiseptic Expectorants.	Respiratory Sedatives.
Camphora (at first) Belladonna Stramonium Hyoscyamus Strychnia Tabacum (briefly) Quebracho Acid. Hydrocy. Dil. (briefly) Physostigma (briefly) Ammonia Alcohol (briefly) Æther ,, Chloroformum ,, Antimonium ,, Ipecacuanha ,,	Scilla Senega Ammoniæ Liquor Ammonii Carb. ,, Chlor. Strychnina Alcohol All Aromatics	Iodum Sulphur Benzoinum Styrax Camphora Cubeba Oleum Terebinthinæ Eucalyptus Creasotum Acidum Carbolicum Pix Liquida Copaiba Balsam. Tolutanum Balsam. Peruvianum Myrrha Ammoniacum Anisi Oleum And other Aromatic Oils	Belladonna Stramonium Hyoscyamus Oleum Terebinthinæ Cannabis Indica Quebracho Amyl Nitris Acid. Hydrocy. Dil. Æthyl Iodidum Opium
Depressants of Respiratory Centre.	**Sedative (Circulatory) Expectorants.**	**Anti-Expectorants.**	**Anti-spasmodics.**
Antimonium Bromides Camphora (at last) Belladonna (at last) Stramonium ,, Hyoscyamus ,, Lobelia Tabacum (chiefly) Chloral Hydras Acid. Hydrocyanic. (chiefly) Aconitum Physostigma Conium Opium Veratria	Antimonium Ipecacuanha Apomorphine Alkalies Iodides Tabacum	Opium Acids Ferrum	Amyl Nitris Conium Potassii Iodidum Belladonna Stramonium Hyoscyamus Lobelia Tabacum Potassii Nitras Opium Chloroformum Æther.
	Saline Expectorants.		
	Potassii Iodidum ,, Bicarb. ,, Citras Sodii Bicarb. ,, Chloridum		

CHAPTER XII.

THE NERVOUS SYSTEM.

THE therapeutical relations of the nervous system are as extensive as those of the whole body itself. Pain, for example, is constantly associated with local disease, and many of the most distressing diseases of the viscera are disturbances of nervous mechanisms. Here we must confine ourselves chiefly to the therapeutical relations of the higher nervous centres, representing sensation, consciousness, and voluntary motion, especially to the means by which we may relieve pain in general, produce unconsciousness, and induce sleep. The student must also clearly understand that we are approaching the therapeutics of the nervous system from the *physiological* side, *i.e.* the treatment of symptoms, only. The treatment of the *pathological* processes, such as hæmorrhage, degeneration, syphilis, which constitute these diseases and cause these symptoms, is another and even more important part of the management of this class of cases, and one which falls under other heads.

I. PHYSIOLOGICAL RELATIONS.

Nervous tissue is a kind of protoplasm with highly specialised properties, which may be resolved into the one great property of displaying or discharging force when brought into contact with certain influences. We name this property *irritability;* the influence which calls it forth, *an irritant;* the act of calling it forth, *irritation.* If the effect be the display of more force than ordinary, we speak of the influence as a *stimulant*, and of the act or result as *stimulation.* If the effect of irritation be the display of less force than ordinary, we say there has been *depression*—that the influence is a *depressant.* Much discussion is still going on as to the nature of irritation, stimulation, and depression, but the points just indicated are clear enough for our present purpose.

Plan of the Nervous System.—The nervous system, though forming one continuous mass of nervous tissue, is built up of a number of *centres*, which are connected with an *irritable surface*, and with the *organs of force.* An impression made on the surface by an irritant is conveyed by an *afferent* nerve, or tract, to the centre; effects there some change upon the protoplasm; and either remains as potential energy, or flows out again through *efferent* tracts and nerves, as an *impulse*, to the organs of force—the muscles, glands, vessels, etc. This process is spoken of as *reflex action.* Nervous substance is, however, not simply irritable, or capable of being brought into action by an impression from without. It can also *originate* action. It is *automatic* as well as reflective. The automatic action of the higher centres is the basis of the emotions, of the intellect, and of the will, and is continually modifying the impulses flowing out of the reflex centres, and *vice versa*, by means of connecting fibres or tracts. In the same way the viscera, such as the heart, are innervated by automatic centres in the medulla or cord, and these are constantly influenced by impressions reaching them from all sides. The highest centres are in the convolutions; the simple automatic and reflex centres in the basal ganglia, cerebellum, medulla, and cord, the whole constituting a series of successive centres, the central nervous system, joined to each other by tracts which associate or co-ordinate the impulses, whilst the outlying systems of ganglia, chiefly automatic in their action, are called the *sympathetic*.

Now we find, when we come to consider the action of drugs and other remedies on the nervous system, that certain of them affect one centre, some another; some afferent parts, others efferent or motor parts; that some drugs affect the lower centres only, some the centres of emotion and intelligence only; and that others again interfere chiefly with the co-ordinating mechanism. We must therefore attempt to arrange the parts of the nervous system on something like a definite plan, before we can comprehend the action of drugs upon it.

Plan of the Nervous System.

I. The terminal irritable apparatus, on the surface of the body, and in the organs.
II. The afferent nerves.
III. The posterior cornua of the cord.
IV. The convolutions.
V. The basal ganglia and cerebellum.
VI. The medulla oblongata.
VII. The antero-lateral tracts and anterior cornua of the cord.
VIII. The co-ordinating fibres between the different centres, especially in the cord, where they form definite columns.

If we were to add to this plan, we might put in the viscera with their nerves. These we have relegated to other chapters; and all that need be indicated at present is that most of the viscera are governed by centres in the medulla, cord, or cerebrum, an arrangement which is partly reflex: that the efferent nerves between the centres and the viscera are intimately connected with the sympathetic chain; and that the viscera have also intrinsic ganglia, by which their automatic action is chiefly carried on.

Sensation.—Sensation is a cerebral state, referable to an impression received through an afferent nerve. This generally originates at the periphery, more rarely in the afferent nerve or tract, but is in every case referred to the periphery. In this way an *impression* (peripheral) becomes a *sensation* (cerebral), and a sensation in turn may or may not travel onwards into a still higher part of the cerebrum, where it becomes a *perception*, a part of *consciousness*, a mental act. Of the various perceptions, common sensibility alone demands special notice here. The tissues and organs in health are sensitive, but not the seat of actual sensations. Very slight disturbance, however, is sufficient to arouse perception or consciousness of the condition of the organs, of which pain is an example, and we therefore assume the constant existence of a quiescent sense, called *common sensibility.*

Motion.—All movement may be said to originate as an *impulse* in a nervous centre, whence it is conveyed to muscles or muscular organs by *efferent* or motor nerves. Thus an impulse arising in the automatic action of the cerebral cells travels from the higher to the lower centres; here it joins the reflex impulse, proceeding by reflexion from these centres; and the mixed impulse courses through the motor nerves to a special *terminal apparatus*, say in a muscle, by which the motor nerve is brought into relation with the organ. Just as a perception in the cerebrum may be referable to a condition of any part of the afferent or sensory side of the nervous system, so muscular contraction may be produced by stimulation of any part of the efferent or motor side, from the convolutions to the muscle itself; and what is of special interest to the therapeutist, it frequently originates, wholly or in part, in stimulation of some part of the sensory side, reflected through the centres.

Consciousness.—This in a purely mental state, partly consisting of perceptions, and partly inseparably associated with the emotions, the intellect, and the will. Consciousness depends on the perfectness of the whole sensory apparatus, but from a practical point of view it may be considered to reside in the cerebral part of the same, *i.e.* in the convolutions, where it is readily reached by the therapeutist.

Sleep.—We cannot account perfectly for natural sleep, but we are probably right in associating it with diminished metabolism of grey matter, whether due to deficient blood supply, to impaired quality of blood, or to the molecular inactivity of the tissues following exhaustion. Sleep bears a definite relation to work, food, and the time of the day, and brings rest and refreshment to the exhausted system.

II. PHARMACODYNAMICS.

When we come to consider how far the nervous system is under our influence, we enter upon a field of enormous proportions, of which we can take but a few examples.

1. *Sensation.*—We have a remarkable power over both common sensibility and the special senses, increasing or diminishing their activity at our pleasure, by means respectively of *local stimulants* and *local anæsthetics.*

a. **Local stimulants.**—This name is given to a great and mixed group of agents, which increase common sensibility or common sensation so much as to cause *pain.* The majority of them act directly upon the *nerve fibrils* in the tissues, such as extreme heat, extreme cold (for a time), faradic electricity, and many drugs, including: Iodine and Bromine; Alcohol, Ether, and Chloroform, when the vapour is confined; Carbolic Acid and Creasote; volatile oils, *e.g.* Turpentine, Cajuput, Menthol, Thymol; acrid essential oils, *e.g.* Mustard and Mezereon: and Cantharides in the first stage. Mineral Acids and Ammonia; Metallic salts, such as those of Silver, Lead, Zinc, Antimony, Mercury, Arsenic, and Copper also stimulate the nerves and cause severe pain, but only when supplied in sufficient strength to interfere markedly with the vessels and protoplasm of the part as caustics or astringents. Possibly some local stimulants act primarily upon the vessels, and many of them no doubt excite the circulation as well as the nerves. It must be carefully noted that the effect of local irritation on the sensory apparatus is really a *central* one. The sensation of pain, although it may be referred to the periphery, is a cerebral state. It therefore affords us a means of rousing the highest centres. What is even more important therapeutically, the whole of the impression conveyed from the irritated spot does not become converted into a painful sensation or act of consciousness. A portion of it, whilst traversing the grey matter of the spinal and medullary centres *en route*, disturbs these and causes reflex impulses, which rouse the muscles and viscera. In this way sensory, and especially *painful* impressions are powerful and readily available means of stimulating not only consciousness but the cardiac, vaso-motor, and respiratory centres, and through them the great viscera themselves. Thus the cold douche produces a sensation of cold referred to the part, rouses consciousness, and so excites the respiratory centre as to cause the gasping movements of breathing familiar under the circumstances. In other words, *local stimulants may become powerful general stimulants.*

b. **Local Anæsthetics.**—Pursuing an exactly opposite line of action, we can readily diminish the sensibility of the origins of nerves until their power of receiving impressions is lost; and thus remove sensations by preventing the very contact of the influence with the nervous system. The measures which have this effect are called **local anæsthetics** (*ἀν, without*, and *αἴσθησις, sensibility*), or, if pain be relieved, **local anodynes** (*ἀν, without*, and *ὀδύνη, pain*). Some of these agents directly depress the nerve fibrils, such as Belladonna, Aconite, Cocaine, and Opium; also Ether, Alcohol, Chloroform, Carbolic Acid, Volatile Oils, and Cantharides, when their application is prolonged. Moderate cold, especially such as is induced by evaporation, is decidedly anæsthetic; and Ether, Spirits, Acetic Acid, Water, and various Saline solutions, *e.g.* of Chloride of Ammonium, possess this property. Prolonged or extreme cold directly reduces the functions of the nerves, causing first numbness, and then absolute anæsthesia. Warmth reduces, and extreme heat destroys, the irritability of the nerves. Other anodynes act partly or wholly through the vessels. Thus moderate heat relieves pain partly by dilating and relieving the blood vessels, and by increasing the blood-supply, the osmosis, and the migration of corpuscles in the tissues—an effect which is assisted by moisture, as familiarly seen in poultices. Cold partly acts by reducing excessive blood supply. The galvanic form of electricity often removes pain very quickly, probably by acting on the nerves, muscles, vessels, and even the metabolism of the part.

The influence of local anæsthetics and anodynes is not confined to the sensorium. With the arrest of sensation, the whole brain passes into a state of rest, and sleep readily occurs. The in-travelling impressions being reduced in strength, the spinal and medullary centres through which they pass, or into which they previously radiated, are no longer excited, and the action of the organs, such as the lungs and heart, becomes more automatic, and, as a rule, but not invariably, more quiet. Thus, as with local irritants, we possess in local anæsthetics and anodynes, a powerful means of influencing the functions of the highest centres, the visceral centres, and the viscera themselves. In other words, *local sedatives may become powerful general sedatives.*

c. All these measures act upon the peripheral structures. The *trunks* of the afferent nerves may also be affected so as to interfere with the convection of the impressions. Opium, and possibly other drugs, heat and cold, electricity, properly regulated pressure, and section or stretching of the nerves are different means of removing sensibility or at least pain.

d. The sensitive and perceptive *centres* in the cerebrum may be the seat of action of anæsthetics. Amongst the substances possessing this effect are Opium, Chloral, Chloroform, Ether, and Cannabis Indica, consciousness as a whole being affected by these measures, which are called **general anæsthetics, general anodynes,** or **narcotics**—a series of titles which will be presently noticed. Lastly, it will be observed that certain substances, such as Opium, arrest the afferent impressions *at every point*—at their formation, in the course of their conduction, and where they impinge upon the sensorium, that is, they act upon the sensory tract from one extremity to the other.

e. The special senses also can be directly influenced by various measures, including drugs. Local anæsthetics reduce the keenness of the sense of touch. Deafness and subjective noises are produced by Quinine, Salicylic Acid, and Alcohol. Santonin causes green vision. Taste is excited by a variety of influences which we have already studied; depressed and peculiarly disturbed by Aconite and other alkaloids.

2. *Motion.*—Our command of the motor side of the nervous system is greater than our influence over sensation, for the reason that motor parts can be acted on not only directly, but also reflexly through sensory parts, as we have just seen—local irritants exciting muscular movements, and local depressants arresting them.

a. Motor stimulants are specially interesting, as different drugs act on different parts of the motor apparatus from the cerebrum to the muscles. Alcohol, in moderate doses, increases the activity of the "motor" *convolutions*, and so probably do Chloroform and Ether for a very short time. *The medulla*, as the centre of the respiratory movements, is excited by Strychnine, Ammonia, Belladonna, and by small doses of Alcohol, Ether, and Chloroform. The *anterior cornua* of the cord (probably in association with the posterior cornua) are powerfully stimulated by Strychnine, convulsions being readily induced. Stimulation of the *motor nerve trunks* can be used to excite the muscles by means of faradaic electricity.

Our most valuable motor stimulants, however, are applied to the *terminations* of the nerves, the *terminal apparatus*, and the *muscles* themselves, in the form of **local motor stimulants.** Strychnine acts also in this way. Electricity is in constant use for this purpose, as the faradaic, occasionally as the galvanic, current. Passive movements of the limbs, rubbing, shampooing, and douching, by rousing the local circulation and metabolism, are also means of preserving or increasing muscular nutrition and activity.

b. Motor depressants are a parallel series of agents. The motor convolutions are disturbed, depressed, and finally completely "paralysed" by large doses of Alcohol, Chloroform, and Ether, which completely arrest all voluntary movements. The motor functions of the *medulla* are so powerfully depressed by Opium, Chloral, Aconite, Conium, Physostigma and large doses of Alcohol and Chloroform, that death from poisoning by these substances occurs in this way. The *anterior cornua* of the cord are depressed by Physostigma and other less powerful drugs, which cause paralysis of the limbs through this channel. The same effect is produced by Conium and other substances, through depression of the *motor nerves*, not of the cord. The *motor nerve-endings* are remarkably under the influence of Belladonna; more, however, those of the involuntary muscles, with which we are not at present concerned. Galvanism is the most powerful local depressant of muscular activity, and is our ordinary means of producing this effect directly.

c. The *co-ordination of movements* is peculiarly interfered with by certain drugs, at any rate by Alcohol, which in considerable doses produces staggering gait, disturbance of the ocular muscles with double vision, thickness of speech, and awkwardness of the manual movements.

3. *Consciousness.*—From the very exalted position which it occupies in the system, consciousness is peculiarly amenable to a variety of influences at our command.

a. It can be *roused* by powerful, especially by painful impressions: for instance, the cold bath or douche; heat, or hot applications such as mustard to the surface; loud sounds, or powerful odours. Besides these, many drugs directly excite the brain, the **cerebral stimulants** and **deliriants**, such as Caffeine, Camphor, Alcohol and Chloroform in the first stage; Opium, Chloral, and Cannabis Indica, in some individuals; Belladonna and its allies; Camphor, Salicylic Acid; laughing gas, etc.

The mental faculties are readily *disordered* by many of the same measures which increase consciousness, leading to laughing, crying, brilliancy of the imagination, increase of the appetites, confusion of the intellect, loss of control of the will, and possibly even delirium in its many forms. Alcohol, Opium, Cannabis Indica, Chloral, Chloroform, Camphor, and Belladonna, are specially active in producing these effects, which are seldom or never desired by the therapeutist for their own sake.

b. Equally valuable are our means of *reducing* consciousness, *or removing* it, and thus producing general anæsthesia, which, in appearance at least, closely resembles sleep, and is associated with suspension of all the other mental faculties. This effect may be secured by temporarily arresting the functions of the convolutions by means of drugs which *directly depress the nervous tissue of the convolutions*, such as Chloroform, Ether, Bichloride of Methylene, Alcohol in large doses, Chloral, and Opium. The Bromides, Caffeine, and Zinc, are valuable **cerebral depressants**, as they diminish reflex excitability, and thus promote rest of the nervous centres. Beyond these, a number of powerful substances, such as Aconite, and other vegetable and mineral poisons, produce a condition of coma with unconsciousness. The question arises, Which of the many active substances which possess this power are convenient and suitable for use? Careful observation has taught us that the *order of involvement of the various parts of the nervous system* by these substances—the line of march of their phenomena—differs widely with the different drugs. With some of them, such as Ether and Chloroform, the very first phenomenon is disturbance of the convolutions; and it is not until consciousness has been completely removed, that any serious depression of the medulla and its vital functions occurs. With others, for example, Opium and Chloral, the cerebrum and medulla appear to be simultaneously and equally involved; and before consciousness has been completely removed, the centres of respiration and circulation in the medulla may be dangerously depressed. A third set of nervous depressants have hopelessly paralysed the medulla before consciousness is much disturbed; such are Aconite and the irritant poisons. In selecting for use a drug which will remove consciousness, we entirely reject the third set. The first set, with Ether and Chloroform as their types, we retain as our **general anæsthetics**; the second set, including chiefly Opium and Chloral, are used under special circumstances, and are generally called **narcotics** (νάρκη, a deep sleep), or, as we have already seen, *anodynes*, pain destroyers.

The action of **narcotics** is very complex, extending from one extremity of the sensory side of the nervous system to the other, influencing also its motor side, and disturbing the sensory, motor, and metabolic functions of most of the viscera. In a person under the full influence of Opium, an impression can only be made with difficulty upon the peripheral nerves, or on the organs of sense; it is slowly and imperfectly conducted; and is imperfectly perceived in the cerebrum. Thus cut off from all but the most powerful external impressions, and itself reduced in activity, the cerebrum is practically in the condition of deep sleep, characterised by unconsciousness. A fact of much greater importance, since unconsciousness is not of itself serious, however prolonged, is that it is accompanied by great depression of the medulla, that is, of the respiration and circulation, which, although sometimes to be turned to useful account, may readily prove injurious or even highly dangerous. We thus possess in narcotics a powerful means (1) of arresting perception, (2) of inducing sleep, and (3) of soothing the great vital functions, all of which may be of the greatest therapeutical service.

4. *Sleep.*—We possess many methods of promoting or producing sleep, which we call **hypnotics** (*ὕπνος*, sleep), or less properly "narcotics." Thus we may be able to secure mental calm, or the absence of noise and light, and to prevent or relieve pain or other disturbing impressions, such as attend indigestion, heart disease, and cough. Along with these *indirect hypnotics*, we may employ *direct hypnotics*, which act on the convolutions, either through the circulation or immediately upon the cells, in either way reducing nervous metabolism. Amongst medicinal hypnotics, the purest are perhaps the Bromides, which appear to bring the brain into a condition which favours the advent of natural sleep, rather than to induce it artificially, if any such distinction can be drawn. Artificial sleep is readily induced by the narcotics proper, including Chloral, Opium, and Alcohol, as well as general anæsthetics, all of which produce hypnotism amongst their other effects, and may be used for this purpose.

III. PATHOLOGICAL RELATIONS.

We will now briefly consider some of the most common and typical disturbances of the nervous system. The organic diseases of this system are of great variety, including morbid states of the vessels, syphilis, degenerations, etc., but it is only the principal symptoms to which they give rise that will be noticed here for the purpose of illustrating the applications of the measures just discussed.

1. *Disturbances of Sensation: Pain.*—Pain is a familiar disturbance of common sensibility of a peculiarly distressing kind. As an expression of disease, whatever the tissue affected, pain always originates in some nervous structure between and including the periphery and the convolutions, but in every instance it is referred to the periphery. When pain is severe, it is accompanied by certain other phenomena, such as mental depression and restlessness, sleeplessness, weakening of the heart, indigestion, and other visceral disturbances. These may be in part effects of the morbid condition on which the pain also depends, but it is to be observed that pain is in itself a powerful depressant of the centres and viscera, just like local depressants of a pharmacodynamical nature.

2. *Paralysis.*—Loss of power, may be taken as an instructive illustration of motor disturbance. Comparably with pain, paralysis depends on injury or disease, of whatever nature, in some part of the motor side of the nervous system—the convolutions, basal ganglia, medulla, lateral column and other motor tracts, the anterior root of the spinal nerve, the nerve trunk, or the terminal motor apparatus in the muscle; occasionally it is distinctly a reflex effect of sensory disturbance: but the paralysis is always seen in the muscle. No class of disease teaches us more clearly the dependence of rational therapeutics upon an accurate knowledge of the anatomy, physiology, and pathology of the parts affected.

3. Side by side with pain and paralysis respectively, there are to be ranged many allied conditions. Thus, allied to pain, and depending like it on disturbance of some part of the *sensory* tract, are the sensations of numbness, coldness, excessive sensibility to touch (hyperæsthesia), excessive sensibility to painful impressions, such as pin-prick (hyperalgesia), and the various disturbances of the special senses; loss of the sense of touch (anæsthesia), loss of the sense of pain (analgesia), and alteration or loss of the organic sensations relating to the stomach, bowels, heart, bladder, etc. In the same way we place beside paralysis other motor disturbances, whether in the form of increased muscular movements—chorea (St. Vitus's dance), tremors, spasms, convulsions, or disturbed movements of the viscera, as of the heart, intestines, uterus, vessel walls, etc.; and we say that they may be due to disease of any part of the motor tract from one extremity to the other, or of some part of the sensory area of the nervous system by reflection through the centres. Reflex spasms, convulsions, and visceral disorders, are especially common.

4. Disturbances of *consciousness*, and of the other higher faculties of the nervous system, include unconsciousness or insensibility, delirium or excitement, and the great class of "diseases of the mind" constituting insanity. Unconsciousness may be the result of injuries to the head; of interference with the blood-supply to the brain, familiarly seen in fainting; of interference with the supply of air to the brain, as in asphyxia; or of poisons, such as alcohol and opium. To these causes we may add organic diseases of the brain, and indeed most diseases just before death. Delirium and other forms of excitement are phenomena of many diseases, and of the action of a variety of poisons, and must be regarded as associated, both as effects and causes, with excessive nervous metabolism, leading rapidly to exhaustion.

5. *Sleep* is most commonly *deficient or absent* when it calls for

treatment; very frequently disturbed; sometimes excessive. Pain is the common cause of insomnia, but sleep may be prevented or broken by cerebral exhaustion (? vascular paralysis) from overwork, by mental anxiety or distress, by oppressed or breathless feelings in the chest, by dyspeptic troubles, and by other distressing sensations, such as irritability of the bladder, spasms of the muscles, and itching of the skin. Sometimes sleeplessness appears to be idiopathic, *i.e.* a disorder *per se.* Excessive *sleepiness*, or continual tendency to sleep, is a result of the retention and circulation in the system of urea or allied products which have not been sufficiently excreted by diseased kidneys; and drowsiness, to a less degree, is a frequent symptom of anæmia, or of disturbed metabolism in the liver, as we saw in the tenth and eleventh chapters. Certain articles of diet, especially alcohol in the form of beer, produce the same effect.

IV. NATURAL RECOVERY.

As the nervous system is the most impressionable of all the tissues, so it seems to possess the power of recovery most quickly and most perfectly from conditions of disorder, when the causes of these are removed. Thus, pain may instantly disappear upon a slight change of temperature, on the application of a weak electrical current, with the alteration of the chemical reaction of the part, or in consequence of the contact with it of a minute quantity of some drug—any of which means will have sufficiently restored its normal condition, or counteracted the abnormal state which gave rise to the distress. In no department of pathology, therefore, is the indication clearer, and encouragement greater, to step in and assist nature by pharmacodynamical measures. Unfortunately, here, as elsewhere, there are certain *limits* to treatment. The disorders of the nervous system to which we have alluded, such as paralysis, spasm, pain, anæsthesia, and disturbances of consciousness and of the mind generally, are too often but the phenomena or symptoms of organic disease of the delicate nervous structures. Scarcely less hopeless is the prospect of curing certain functional disorders of the nervous system, without discoverable anatomical cause, such as epilepsy and hysteria. But even in both these classes of cases, many of the most urgent symptoms, and the severity and frequency of others, can be mitigated by the measures which we have just reviewed, as we shall now attempt to show.

V. THERAPEUTICS.

In drawing a rational conclusion from what we have studied under the four preceding heads, we approach, as we proposed, the consideration of the therapeutics of the nervous system chiefly from the point of view of symptoms.

1. *Disturbances of Sensation: Pain, and the use of Anodynes.*—Our review of the physiological and pathological relations of pain leads us to its rational treatment. We must discover, first, its morbid cause, and secondly its exact physiological significance, and apply our measures accordingly.

The scientific use of anodynes, as we have already suggested, is founded upon correct diagnosis. It will frequently be found that when the cause is known, pain can be removed without the employment of any nervine remedy, and in every instance this treatment should be entertained or attempted. An abscess will be relieved by the knife, headache by purgation, syphilitic periostitis by Iodides. We thus discover a great group of measures which, whilst they are not anæsthetics, are *indirect anodynes*, because they attack the pathological cause of the pain, and do not immediately act upon nervous tissue. *For practical purposes*, anodynes may be classified into (1) *indirect anodynes;* (2) *direct anodynes which act on the peripheral nerves only;* and (3) *direct anodynes which act on the centres as well as the periphery.* In many instances these may be combined.

a. Indirect anodynes are necessarily a heterogeneous group, and include surgical operations of every kind, which are amongst the readiest and most radical of all, *e.g.* opening abscesses, simple physical protectives, such as ointments and oils in burns; poultices and warm fomentations, and cold in various forms.

Local irritants, such as mustard and blistering agents, which cause much pain at first, may become local anodynes by producing an effect which is called *counter-irritation.* We shall discuss fully this class of remedies in chapter xv., but we may for the present refer their action to exhaustion of the irritability and conductivity of the local nerves, to dilatation of the vessels and relief of anæmia, and to some influence on the nervous centres corresponding to the affected part. Another powerful natural group of local anodynes, which are chiefly indirect, but partly also direct, in their action, consists of the essential oils, such as Turpentine, Camphor, and the Oils of Cloves, Mint, etc. These have a complex action: they destroy the organisms of disease by virtue of being antiseptic; they dilate the vessels, causing redness and heat; and they depress the peripheral nerves after temporary pain. Certain allied artificial products possess a similar indirect and direct anodyne power, *e.g.* Carbolic Acid and Creasote. Besides these *local* indirect anodynes, we possess an unlimited number which act *generally*; as many, indeed, as the remediable causes of pain. Thus, headaches may be relieved, under different circumstances, by any of the local measures just enumerated, or by such diverse general remedies as purgatives, Quinine, Iron, Iodides, and Alcohol, quite independently of the direct anodynes which we may consider it necessary to apply.

b. Local Anodynes.—When treatment directed to the cause of the pain fails or is insufficient, we must next attempt to reduce the irritability of the nerves by local means. Direct *local anodynes* may now be rationally employed. Thus in neuralgia, constitutional treatment must be combined with the application of a local anodyne sufficiently powerful to interfere with the reception and conduction of impressions. We therefore employ Aconite, Belladonna, Opium, the confined vapour of Chloroform, Alcohol, or Ether, the Volatile Oils, Carbolic Acid, Creasote, heat (which must often be extreme), extreme cold, the continuous current, or local nervous irritants. Most of the drugs mentioned are applied in the form of liniments, lotions, or ointments. Morphine may be administered by the endermic or hypodermic method, the former being now almost entirely superseded by the latter, which is by far the most valuable of all anodyne measures, from the readiness with which it can be given, and the rapidity and completeness of its action. Alcohol or Chloroform may be poured on lint and evaporation prevented, or rubbed on and the part covered.

c. General Anodynes.—When pain is very severe, sleep impossible, and the whole system distressed and disordered, direct general anodynes are demanded. The most useful is Opium or Morphia, which may be given in a great variety of forms, and by several channels, the most ready and powerful of all being the hypodermic method. Chloral, Butyl-chloral, and Cannabis Indica, are other general anodynes in use, but are greatly inferior to opium. The narcotic or hypnotic effect of these anodynes is taken advantage of, as a rule, by prescribing them at the usual hour of sleep.

Where the pain is unbearable, and relief must be not only complete but instant, even these powerful anodynes may be unavailing. In such cases *general anæsthetics* must be employed: the patient must be put under the influence of Chloroform or Ether. Such are the pains of labour, or of the passage of calculus, the pain attending the reduction of a dislocation or a severe surgical operation. Consciousness is quickly abolished, kept in abeyance, and allowed to return when the cause of the pain has ceased. The necessity for such powerful remedies in some instances of pain will impress on the student the importance of sparing the nervous system, and the viscera which are reflexly depressed along with it, in every case of pain.

Food and stimulants are, as a rule, urgently indicated in protracted pain.

2. *Loss of Common Sensibility.*—Neither this nor the allied condition of loss of touch (*anæsthesia*) very often calls for treatment, and the large number of nerve irritants which we possess in the Acids, Metallic Salts, Mustard, etc., are seldom used for this purpose. Pyrethrum is sometimes given in anæsthesia of the mouth.

3. *Paralysis.*—The rational treatment of paralysis will depend entirely on its nature, and the seat of its cause; and this, as in the case of pain, must be ascertained as accurately as possible. If the lesion be cerebral, general remedies must be directed to relieve the pathological state, such as Mercury in syphilis, cardiac measures in vascular rupture, and so on. Rest of the mind, *e.g.* by Bromides, will be all important. There is no indication, as a rule, to increase the activity of the damaged centres, except after a time by the use of the will; on the contrary, all cerebral stimulants, such as alcohol, are better to be avoided. In paralysis from disease of the cord, the same general system of treatment is to be followed, but Strychnine may be tried as a direct stimulant of the affected part, sometimes with success. In paralysis due to injury or disease of the nerve trunks or peripheral nerves, the cause must be carefully searched for and if possible removed, *e.g.* tumours. The local injection of Strychnine appears to benefit some cases. In every kind of paralysis, local treatment must be carried on along with general, and consists chiefly in exercise of the terminal nerves and muscles by electricity, friction, and passive movements, with the view of sustaining the local circulation and nutrition until the centres shall have been restored.

4. *Excessive Motor Activity*—in the form of spasm, tremors, and convulsions—being generally due to peripheral irritation reflected through the centres, is rationally treated by removal of the cause. The convulsions of children, for instance, are generally to be treated by stomachics and purgatives; the spasms of adults by carminatives. But in many cases it may be necessary also to employ remedies which depress the reflective centres, such as the Bromides and Opium. When the cerebrum is believed to be the seat of disorder or disease attended by these symptoms, *e.g.* epilepsy, the Bromides are of great service, whilst tetanus, hydrophobia, and other spasmodic diseases with better defined organic causes in the cord and medulla, may be rationally treated by Physostigma and Chloral. It cannot be said, however, that much success rewards such treatment, possibly because employed, as a rule, too late. When the spasm appears to be due to purely local

causes, Belladonna and Conium are often of use, *e.g.* in chordee, spasmodic asthma, and laryngismus. The continuous battery current and counter-irritants relieve painful spasm of the voluntary muscles. Lastly, Opium again is a most powerful antispasmodic for general use.

5. *Consciousness* may be said to demand temporary *removal*, in anticipation of the excessive pain and anxiety attending operations. The general anæsthetics in common use are Ether and Chloroform, the selection and use of which are fully described under their special therapeutics. Conditions of *excitement*, such as delirium and mania, are to be met by two sets of remedies, which must always be combined—viz. first, cerebral depressants, such as Opium, Chloral, Hyoscyamus, Bromides, and, if necessary, Chloroform; and secondly, general nutrients and stimulants, chiefly in the form of abundant food, and possibly a certain amount of alcohol. Judicious moral treatment is an indispensable accompaniment.

6. *Loss of consciousness* appears to require and receive treatment in cases of fainting, drowning, accidents to the head, etc., but the great centres of respiration and circulation are the real objects of our anxiety. They have been depressed along with the convolutions, and must be restored to activity if life is to be preserved. Restorative measures include the re-establishment of the general and cerebral circulation by the recumbent posture and cardiac stimulants, and of respiration by artificial chest movements and abundance of fresh air. Local nervous irritants such as cold affusion, flagellation, or mustard applied to sensitive parts, powerful odours, and Ammonia, must each or all be employed.

7. *Disorders of Sleep* will be rationally treated by pursuing the course suggested by our previous considerations. *Insomnia* may be met by the many indirect and direct hypnotics. In every instance full advantage must be taken of the indirect group. Bromides are indicated when the cerebral circulation is excited by overwork ; and Chloral may be combined with it. When pain is present Opium only will induce sleep. When there is much mental distress Opium is again necessary, and Alcohol at bedtime may be invaluable. In every instance the time of administration of hypnotics must be carefully ordered. Further, it must never be forgotten that the narcotics, including Opium, Morphine, and Chloral, are all powerful depressants of the respiration, circulation and excretions, and may thus produce disastrous results whilst they afford the temporary advantage of sleep.

SUBSTANCES WHICH ACT ON THE NERVOUS SYSTEM.

LOCAL STIMULANTS.

Alcohol
Æther
Chloroformum
Ammonia (at first)
Acid. Carbolic. (at first)
Creasotum (at first)
Oleum Terebinthinæ
Veratrina (at first)
Cantharis (at first)
Potassa Caustica
Argenti Nitras
Plumbum
Zinci Chloridum
Hydrargyrum (at first)
Iodum (at first)
Bromum
Arsenicum
Antimonium
All Aromatic Oils
,, Oleo-resins
,, Resins
,, Balsams
Acrid Oils.
Mineral Acids.

LOCAL ANÆSTHETICS; LOCAL ANODYNES.

Belladonna
Stramonium
Hyoscyamus
(?) Conium
Bromides
Opium
Alcohol
Chloroformum (chiefly)
Acid. Carbolic. (at last)
Creasotum (at last)
Acid. Hydrocyanic. Dil.
Sodii Bicarb.
Creta
Aconitum
Ol. Terebinthinæ
Pix
Veratrina (at last)
Cantharis
Zinci Oxidum (at last)
Iodum (at last)
Local Refrigerants.

LOCAL ANÆSTHETICS; LOCAL ANODYNES (continued).

Bismuthum
All Aromatic Oils.
,, Oleo-resins
,, Resins
,, Balsams

CEREBRAL STIMULANTS AND DELIRANTS.

Belladonna (at first)
Stramonium (,,)
Hyoscyamus (,,)
Tabacum
Santoninum
Camphora
Alcohol (at first)
Chloroformum (briefly)
Coffee (at first)
Guarana ,,
Theobroma ,,
Cannabis Ind. (at first)
Lupulus (at first)
Opium (at first)

CEREBRAL DEPRESSANTS.

Bromides
Acid. Hydrocyanic. Dil.
Coffee (at last)
Tea (at last)
Guarana
Theobroma
Ol. Terebinthinæ
Potassium
Lithium
(?) Argentum
(?) Cuprum
Zincum
Arsenicum (?)
Antimonium

HYPNOTICS.

Bromides
Narcotics
General Anæsthetics.

SUBSTANCES WHICH ACT ON THE NERVOUS SYSTEM (*continued*).

NARCOTICS.	STIMULANTS OF MOTOR CENTRES OF CORD.	DEPRESSANTS OF MOTOR CENTRES OF CORD (*continued*).	DEPRESSANTS OF MOTOR NERVES AND NERVE ENDINGS.
Opium (at last) Chloral Hydras Belladonna (at last) Stramonium Hyoscyamus Alcohol (at last) Cannabis Ind. (at last) Lupulus (at last)	Nux Vomica and Strychnina Chloroformum (at first) Æther (at first) Ergota (at first) Opium (briefly) Ammonia	Gelsemium Opium (at last) Potassium Lithium (?) Argeutum (?) Cuprum Zincum (?) Arsenicum	Conium Belladonna Stramonium Hyoscyamus Amyl Nitris Acid. Hydrocyanic. Dil. Opium
GENERAL ANÆSTHETICS.	DEPRESSANTS OF MOTOR CENTRES OF CORD.	STIMULANTS OF MOTOR NERVE ENDINGS.	REFLEX MOTOR STIMULANTS.
Nitrous Oxide Chloroformum Æther Bichlor. of Methylene Dichlor. of Ethidene Æthyl Bromidum	Physostigma Camphora Bromides Alcohol Chloroformum (at last) Æther (at last) Amyl Nitris Sodii Nitris Ergota (at last)	Strychnina and Nux Vom. Opium (briefly)	Strychnina Counter-irritants Carminatives Ammonia

CHAPTER XIII.

THE KIDNEY.

THE position which the kidney occupies in the circle of the great physiological systems gives a special character to its diseases, and to the actions and uses of remedies in connection with it. The series of vital processes which commences with the admission of food, air, and medicines, ends chiefly with the excretion of urine. Digestion, assimilation, sanguification, metabolism, circulation, and respiration, all, therefore, affect the activity of the kidney. This is chiefly due to the fact that the kidney does not itself form the urea, uric acid, pigments, salts, and water which form the bulk of the urine —that these bodies reach it by the blood, and it has but to sweep them from the circulation. This dependent position of the kidney is of great interest to the practical therapeutist. Clinically, the condition of the urine is a key to the manner in which the various viscera are discharging their functions; pathologically, we often find in other organs the cause of renal disease; and pharmacologically, we discover that if we wish to affect the composition of the urine and the activity of the kidney, we must, in many cases, direct our measures to the digestive organs, the heart and the vessels.

Conversely, the kidney makes its influence felt backwards upon the other organs. Disturbance of the renal function quickly tells upon the blood and viscera. We saw this under the heads of the liver and metabolism, and noted how quickly the retention of waste products checks functional activity, like ashes choking out a fire. As striking a relation exists between the kidney and the organs of circulation. Thus the practitioner, adopting the inverse order of investigation, estimates the condition of the kidney by the pulse, bowels, and appetite; the pathologist finds in the enlarged heart and ruptured vessels of the brain the outcome of disease of the renal glomeruli; and the pharmacologist relieves the blood pressure or the liver by measures directed to the kidneys. These preliminary considerations will prepare us for the systematic discussion of this complex subject.

I. PHYSIOLOGICAL RELATIONS.

The source of the urine is believed to be certainly double. The bulk of the *water* is excreted in the Malpighian bodies, being squeezed from the glomerulus into the capsule by the blood pressure within the former. The excreting force is determined (1) by the pressure of the blood entering the glomerulus by the afferent vessel, and (2) by the resistance to its flow through the efferent vessel; whilst the freedom of filtration depends upon the fact that the uriniferous tubules have a free outlet, and thus present but little obstruction to the entry of water into their channel.

The size of the renal vessels is regulated by vaso-motor nerves, coming chiefly from the splanchnics, which derive their renal fibres from the medulla oblongata, in part at least through the first thoracic ganglion. The spot in the fourth ventricle which thus presides over the vessels of the kidney is a *centre, i.e.* it receives impressions through afferent nerves, and sends impulses through efferent nerves to the kidneys. Thus powerful emotions will disturb the flow of urine, and the temperature of the surface of the body affects the amount of urine secreted, partly at least reflexly.

The *solid constituents* of the urine—urea, uric acid, and their allies, and many of the salts, dissolved of course in a small quantity of water—are probably separated from the blood by the cells of the convoluted tubules. The activity of the renal epithelium no doubt depends, like that of the salivary glands, upon an inherent secreting force of its own, probably controlled by trophic nerves; upon the activity of the circulation; and especially upon the quality of the blood. We have already seen that the materials which the blood conveys to the kidney for excretion will depend upon the activity of all the bodily functions, and we will not return to this subject except with respect to *the influence of digestion and assimilation on the urine.* During gastric digestion a quantity of acid is withdrawn from the blood to furnish the gastric juice, and this loss of acidity in a fluid already alkaline makes itself felt in the urine, which soon becomes less acid, or even alkaline. This reaction increases when absorption begins. Water and salts enter the blood; augment still further the alkalinity of the urine, the salts being chiefly alkaline, and the total volume of the blood, and thus of the renal secretion, is increased; the arterial pressure rises. Finally, the products of the action of the liver, lungs, and other metabolic organs upon the peptones and carbohydrates (urea and its allies) also enter the blood and appear in the urine, in comparative excess. This condition of the urinary function and urine, consequent on a full meal, gradually declines. The excess of water escapes; the alkaline salts are voided; the excess of urea and uric acid disappears; and therewith the general characters of the urine change. By the end of three or four hours from the admission of food, the urine is again moderate in amount, more acid, and clear, an increase of acidity following the previous reduction.

II. PHARMACODYNAMICS.

The preceding considerations prepare us for the conclusion that what power we may possess over the excretion of urine will be exercised, as far as its water is concerned, chiefly through the circulation; as far as the solids are concerned, chiefly through the blood. These points must be separately studied.

1. *Measures for Increasing the Volume of Urine.*—The amount of water, that is, the volume of urine which is excreted from the glomerulus, may be increased by **diuretics**, the effect being called *diuresis* (διὰ through and οὖρον the urine). This may be accomplished in various ways:

(*a*) *By raising the pressure in the arteries generally, including the renal*, whilst the pressure in the veins is constant. This is most easily effected by temporarily increasing the amount of water in the system by drinking; by raising the force or the frequency of the heart, or both, by Alcohol, Digitalis, Scilla, Ammonia, and Scoparium; or by constricting the peripheral vessels through the vasomotor system, *e.g.* by cold to the surface, Digitalis, Scilla, or other vascular stimulants. These measures are called **cardio-vascular diuretics.**

(*b*) *By dilating the renal arteries*, so that the quantity of blood within them is increased, whilst the pressure in the arterial system generally, and the resistance in the renal veins, remain unchanged. This method of increasing the amount of the renal water may be carried out by acting on the vaso-motor system of the kidney either locally or centrally. Local depressants of the renal nerves include Digitalis and Scilla in the second stage; Spirit of Nitrous Ether; all Volatile Oils and Resins, such as Turpentine, Juniper, Copaiba, Hops, Savin, Cantharides, Camphor, etc.; Alcohol, Belladonna, Aconite, Nitrates, and Nitrites. Central renal vascular depressants are chiefly or solely emotional impressions which are not available as pharmacodynamical means. A powerful reflex dilator of the renal vessels is cold to the surface. Such measures are **local vascular diuretics.**

(*c*) *By combining the two previous means*, when still more profuse diuresis will be the result. This occurs in the second stage of the action of Digitalis and Scilla, and in the application of cold to the surface.

2. *Measures for Diminishing the Volume of Urine.*—The volume of urine might be diminished by employing the opposite set of influences to those just described. These are obscure, however, and of less therapeutical interest; and the student may be left to work out the different systems for himself.

3. *Measures affecting the Secretion of Urinary Solids.*—The

activity of the *renal epithelium*, *i.e.* the excretion of solids and of a certain amount of the water, may be modified by influences of two classes:

(*a*) *By measures and conditions which affect the renal cells through the composition of the blood in general.*—Of these, the state of digestion, including the selection of food, is the most important. The quantity of food; its richness in proteids, carbohydrates, and salts of different kinds; the relative amount of work thrown upon gastric or acid, and duodenal or alkaline digestion; and the vigour of hepatic metabolism, as determined by so many causes, including exercise, oxygenation, and the use of drugs—may all be made use of by the pharmacologist in altering the composition of the urinary solids.

One of the most easy and important of these alterations is in the *chemical reaction* of the urine. The natural acidity of the urine can be *increased* by excess of proteids, sugar, and starch, by deficiency of water, by certain wines and spirits, by Salicylic and Benzoic Acids, and by an excess of Tartaric and Citric Acids. The mineral acids have an insignificant or even negative power on the acidity of the urine, a fact which is to be carefully noted. Sulphuric Acid is excreted by the kidneys (in part), but as neutral sulphates; Hydrochloric Acid as neutral chlorides, Phosphoric Acid as phosphates; Nitric Acid is believed to increase the ammonia in the urine by decomposition in the blood, so that it may have an alkaline influence; and Tartaric, Citric, and Acetic Acids in combination with Alkaline bases, escape as Alkaline Carbonates.

On the other hand, we possess abundant and powerful means of rendering the urine *alkaline*. Amongst foods, the most effective in this direction are fruits, milk, and fish, as they throw into the blood a quantity of Alkaline Citrates, Tartrates, Acetates, Carbonates, and Phosphates, which are directly or indirectly excreted by the kidneys. Amongst drugs, the whole group of Alkalies and Alkaline Earths have an alkalinising effect on the urine, excepting Ammonia, which is completely broken up in the system. Thus the alkalies are entirely unlike the mineral acids in exercising a powerful and available influence on the reaction of the urine.

(*b*) *By measures which affect the renal epithelium specifically.* Whatever may be their alkalinising value in the blood, certain substances have a special influence on the urine by *specifically acting upon* the renal cells. Thus Potash and Soda possess equal values as alkalinisers of the *blood*, but potash will much more powerfully and quickly neutralise the acidity of the *urine*, because whilst Soda is excreted partly by the bile and bronchial mucus, or locked up in the system as the neutral chloride of sodium, Potash stimulates the renal epithelium, which excretes it as the carbonate. Soda does, however, possess a degree of specific action on the kidney, especially its Phosphate and Acetate. Lithia closely resembles Potash in this respect; Ammonia, although not an alkaliniser, has a similar influence; and Magnesia and Lime are distinctly stimulants of the renal epithelium, as is well seen in some natural mineral waters. Now, in passing through the cells, these salts necessarily carry with them a certain amount of water from the venous plexus around the tubules, and if abundant, actually produce diuresis. They thus furnish us with another group of diuretic measures, which we call the **saline diuretics**, chiefly alkaline in their influence on the blood and urine, but at the same time independently active as specific renal stimulants. Let it be carefully noted that the saline diuretics do not, as far as we know, directly affect the renal circulation; but that we possess in them an indirect means of influencing the venous plexus around the tubules, and thus the whole renal circulation and the general blood pressure, especially the pressure in the veins.

Another great group of natural substances in the materia medica have a specific effect on the renal epithelium, namely, the Aromatic Oils, Oleo-resins, and Balsams. The chief of these are Turpentine, Juniper, Copaiba, Cubebs, Cantharides, and Hops; whilst Jaborandi, Alcohol, Aconite, and many more act partly in the same way. All these substances, either as such or after decomposition, are excreted (in part) by the renal cells, and carry with them, like salines, so much water, besides dilating the renal vessels, as we have already seen. The degree in which the different members of this great class act upon the renal cells varies widely, however: thus, Juniper and Copaiba are powerful diuretics, greatly increasing the urinary flow, whilst most of the others have but little effect on the volume of urine, possibly because their action on the renal vessels, which accompanies their action on the cells, does not favour the escape of fluid. Thus Turpentine and Cantharides, two most powerful renal stimulants, sometimes diminish, sometimes increase, the urinary water, and may even cause hæmorrhage from the glomerulus.

Opposed to these renal stimulants are *renal sedatives or depressants*, which appear to diminish directly the activity of the renal cells, when they reach them through the blood. Morphine has this effect, and possibly Quinine and other substances.

III. PATHOLOGICAL RELATIONS.

The disorders of the renal functions, which will be taken by us to illustrate the application of the measures just noticed, may be summarised as follows:

1. *Disorders of the fluid secretion referable to the general blood pressure.*—(*a*) *Diminution of the general arterial pressure*, which is generally referable to heart disease, leads to marked disturbance of the urinary flow. We saw under the head of the circulation (page 472) how dilatation of the heart lowers the pressure in the arteries and raises it in the veins, *i.e.* lowers it in the afferent vessel of the glomerulus, and raises it in the efferent vessel, thus causing *congestion of the kidneys.* The urine in this class of cases contains albumen and blood proceeding from the engorged veins; it falls in quantity in consequence of the fall in the arterial pressure, and of obstruction in the tubules, which become choked with fibrinous casts; and the total excretion of solids is diminished, as the result of retardation of the blood current.

(*b*) *Increase of the general arterial pressure* is associated with that form of chronic disease of the kidney known as the "Granular or Contracted Kidney." Here the urine is very abundant, probably reaching several times its normal volume, very light in colour and weight, and may contain a trace of albumen. The tension of the radial artery is high; the left ventricle is hypertrophied; and the patient often dies of secondary dilatation of the heart, or of rupture of an artery in the brain. As far as the kidney is concerned, the condition is one of constant pathological diuresis.

2. *Disorders of the fluid secretion, referable to the local blood pressure.*—(*a*) *Certain nervous conditions* disturb the pressure in the kidney by causing contraction or dilatation of the renal vessels, and thus modifying the amount of urinary water. Such a condition may be either central or local, direct or reflex. Thus hysteria is attended by alternately profuse and deficient flow of urine. Disease of the medulla and its neighbourhood may give rise to profuse diuresis (*diabetes insipidus*), which has been traced in other cases to disease of the renal nerves. Reflexly, the chief cause of disturbance of the renal secretion is injury or disease of the prostate or urethra, which may even lead to fatal suppression.

b. Morbid conditions of the blood-vessels of the kidney, such as disease of the glomeruli, arteries and veins, which constitute one of the elements of Bright's disease, produce a variety of disturbances in the volume and constitution of the urine, according to their exact seat and degree. Pressure on the trunks of the renal vessels by abdominal enlargements may also cause serious disturbance of the renal circulation, with albuminuria, hæmorrhage, or even suppression of urine as the result.

3. *Disease of the secreting epithelium.*—This constitutes another element of Bright's disease. The diseased cells fail in function, choke up the tubules, press upon the venous plexus, and thus give rise at once to stagnation of the blood current and resistance to the filtration of water through the glomerulus. The clinical phenomena of this condition (commonly called the Large White Kidney), are very definite. The urine falls in volume; the solids are absolutely diminished, but relatively increased, so that the specific gravity is high; and in their place there appear albumen, probably derived directly from the venous plexus, blood from the same source or from the glomeruli, and casts formed of diseased cells, fibrin, etc. The blood becomes poisoned by retention of urea. The systemic vessels become diseased, and the heart hypertrophied; and the blood-change and cardio-vascular disease together lead to marked breathlessness, and to escape of the watery parts of the blood into the tissues and serous cavities, constituting renal dropsy.

4. *Rise of pressure within the uriniferous tubules* is a serious cause of complete arrest of the secretion. This is one of the effects of fulness of the venous plexus, and of epithelial accumulations in the tubes, already noticed; and may also originate in obstruction of the ureter, disease or injury of the bladder and prostate, or stricture of the urethra.

5. *The condition of the blood.*—This is the most common of all the causes of derangement of the urinary secretion. A number of the disorders of the urine, as regards its reaction and relative composition, can be traced to dyspepsia, hepatic derangement, and defective oxygenation or metabolism; and even albumen, sugar, and bile may find their way into the urine from the same causes. One striking disorder of the urine is characterised by unnatural alkalinity and by its effects in precipitating the solid constituents. The urine is turbid from precipitation of phosphates, carbonates, and urates; and these are deposited in the passages, causing pain and irritation. If the natural acidity of the urine between meals be insufficient to dissolve these alkaline deposits, concretions are formed, and grow at each period of indigestion, until they form a *calculus*, which may travel downwards and be expelled with the urine after great suffering.

A similar disorder of the urine is characterised by excessive acidity. This has different causal relations, but the ultimate effects are practically the same—the precipitation of uric acid and urates, and possibly the formation of calculus. Excessive acidity is chiefly met with in the subjects of disorder of the liver from indulgence in proteid food (*see* page 443); and may be accompanied by an excess of urea, diminution of water, and occasionally by traces of albumen and sugar.

IV. NATURAL RECOVERY.

So many of the disorders of the urine are but expressions of derangement of the blood and of the great organic functions, that it is hardly necessary to say that natural recovery constantly occurs. Conversely, improvement in the condition of the urine is an evidence of the spontaneous return of the stomach, intestines, liver, heart, etc., to the normal state when the causes of their disorder have been removed.

The kidney possesses several provisions for natural recovery. It meets increased work by increased action; compensatory hypertrophy of one kidney occurs if the other kidney fail; and a close vicarious relation exists between the kidney and the skin and bowels. The practical therapeutist closely follows these natural methods in arranging his treatment.

V. THERAPEUTICS.

A careful consideration of the four preceding sections specially impresses two facts upon us. First, the rational treatment of any case of renal or urinary disorders must be founded upon an appreciation of the influences of other organs upon the kidneys; and, secondly, treatment may be as often directed to the kidneys for diseases of other organs as when they are themselves at fault: diuretics will be as frequently employed to relieve the heart as to stimulate the cells of the kidney.

1. (*a*) *Renal congestion from heart disease.*—This may be taken as the type of renal disorder from diminished blood-pressure, whatever its cause; and such being the pathology of the condition, the line of rational treatment is obvious. To remove the cause we must restore the normal relations of the general circulation, that is, strengthen the heart, fill and keep full the arteries, and empty the veins. How this is to be done has been already discussed in chapter x., and need not be repeated here. We are now able to estimate the value of two sets of diuretic remedies which are successfully employed in such cases, namely, the *cardio-vascular diuretics*, and the *saline diuretics*. Digitalis and Squill exactly fulfil the indications just mentioned as regards the heart, the arteries, and the veins. They increase the cardiac vigour and the period of rest; sustain the arterial tension at a moderate height; and empty the veins forwards by prolonging the diastole. At the same time, partly by these effects and partly by their local action on the renal vessels, they cause a true diuresis from the Malpighian bodies, and increase the force of the circulation through the renal veins. Ammonia, Alcohol, or Scoparium, may be combined with these drugs; and here it may be remarked, once for

all, that combination is peculiarly useful in diuretics. Saline purgatives also assist this action. Thus Sulphates of Sodium and Magnesium, Acid Tartrate of Potassium, Tartrate of Sodium and Potassium, Acetate of Potassium, Citrate of Potassium or Ammonium, are, in the first place, saline purgatives, thus relieving general venous congestion; and, secondly, act upon the renal epithelium, draining the over-distended venous plexus, and accelerating the circulation through the glomerulus. In other instances dilators of the renal vessels may be combined with these remedies, including Juniper and Spirit of Nitrous Ether.

(*b*) *Disorder or disease of the kidney in association with excessive blood pressure; Bright's disease with contracted kidney.*—In the early stages of this disease, when its cause may be discovered in indulgence in food and alcohol, or disorder of the liver, the treatment consists in a thorough reform of diet, free purgation, and elimination generally. Mercurial purgatives followed by salines are especially valuable. In the more advanced and grave form of high arterial tension, the cause is usually beyond our power. All that can then be done is to counteract the cause, remove its evil effects, and treat symptoms. The food should be moderate in quantity, and chiefly non-nitrogenous; stimulants must be avoided; moderate rest of body and mind insured; and various drugs administered. We are unfortunate in possessing but few medicinal means of reducing peripheral resistance for any length of time without depressing the heart; but the Iodide, Chlorate, Nitrate, and other salts of Potassium, Nitrite of Sodium, Belladonna, and its allies may be tried. Warmth is essential in these cases.

2. (*a*) *Urinary derangements from nervous disorder or disease.*—The treatment employed here must be entirely directed to the nervous system. Bromide of Potassium, Valerian, and other anti-spasmodics, including moral treatment, will relieve hysterical diuresis; and Opium and Ergot are successful in many cases of polyuria of obscure and probably nervous origin.

(*b*) *Local vascular disease.*—If the emulgent veins are obstructed by abdominal enlargement, this must be immediately removed, if possible—by tapping the peritoneum, for example, or by inducing premature labour. In disease of the renal vessels we can do but little by way of direct treatment beyond relieving symptoms as they arise; regulating the flow of urine as well as possible, especially stimulating it if it threaten to become deficient; and removing the excrementitious products by the bowels and skin, when the specific gravity falls.

3. *Disease of the tubules; "Acute Desquamative Nephritis,"*

"*Large White Kidney.*"—This is the form of kidney disease in which there is the greatest or most constant danger of deficient excretion, and of the consequences of the same throughout the system. The indications for treatment are obvious. We must relieve the diseased cells of as much work as can be safely dispensed with by the blood and tissues. The rational methods of relieving the renal epithelium are: (1) by reducing the food in quality and richness; and (2) by diverting the excrementitious products to other channels. Hydragogue purgatives are especially valuable in this form of Bright's disease; and the warm air or vapour or water bath, warm drinks, and Jaborandi, will successfully relieve the kidneys by perspiration. Renal stimulants, such as the saline and specific diuretics, might, on the other hand, exhaust the cells, already weakened by disease; but in certain cases they are highly useful even in this condition, for they may exert that amount of stimulation on the renal cells which, on the principle of alteratives in general, will lead to their restoration. If we believe that the tubules are blocked by cellular and inflammatory products, we must clear them by a system of flushing, or diuresis. For this purpose Distilled Water is the best diuretic; Digitalis and Squill are also valuable, as producing but little local irritation, and tending to prevent venous congestion.

In this or in any other form of renal disease, urgent symptoms of uræmia must be quickly relieved by venesection, the administration of Chloroform, free purgation, and, if possible, profuse diaphoresis. The anæmia generally demands Iron in some form.

4. *Obstruction in the urinary passages.*—The most common cause of this serious disease, namely, stricture of the urethra, is fortunately accessible, and amenable to surgical treatment. When the obstruction is above the bladder it is very rarely bilateral, and the unaffected kidney takes on the double function of the two.

5. *Disorders of the blood, liver, and digestion; Gravel and Calculus.*—The immediate treatment of these secondary disorders of the liver, in their early stage, has been already suggested: careful low dieting, and the occasional administration of cholagogue purgatives, stomachics, and antacids. If gravel or calculus have actually formed. several other measures are still open to us, whilst the same line of treatment is persevered in to prevent further growth. We may attempt to dissolve the stone *in situ* by the continuous administration of Citrate of Potassium, or of acids, as the nature of the calculus demands, and may relieve pain, hæmorrhage, mucous and purulent discharges on general principles.

Synopsis of Substances which act on the Kidney.

<table>
<tr><th colspan="3">A. MEASURES WHICH ACT UPON THE RENAL CIRCULATION.</th><th colspan="4">B. MEASURES WHICH ACT UPON THE RENAL CELLS.</th><th rowspan="3">Urinary (Vesical) Sedatives and Anti-spasmodics.</th></tr>
<tr><th colspan="2">Measures which Increase the Volume of Urine through the Circulation: Cardio-Vascular Diuretics.</th><th rowspan="2">Measures which Diminish the Volume of Urine through General Circulation.</th><th rowspan="2">Measures which act upon the Renal Cells through the Blood in general.</th><th colspan="3">Measures which act specifically upon the Renal Cells: Glandular Diuretics.</th></tr>
<tr><th>RAISE GENERAL BLOOD PRESSURE.</th><th>DILATE RENAL ARTERIES.</th><th>SALINE DIURETICS.</th><th>SPECIFIC RENAL STIMULANTS.</th><th>RENAL ALTERATIVES.</th></tr>
<tr><td rowspan="3">Aqua Destill.
Alcohol
Digitalis (1st stage)
Scilla ,,
Convallaria
Ammonia
Scoparium (?)
Senega</td><td rowspan="2">Digitalis (2nd stage)
Scilla ,,
Alcohol
Spiritus Ætheris Nitrosi
Volatile Oils
Resins
Oleo-Resins
Balsams
Salicylates
Nitrates
Nitrites</td><td rowspan="3">Opium
Ergota</td><td>URINARY ALKALINISERS.
Potassium
Sodium
Lithium
Calcium
Magnesium</td><td rowspan="3">Potassii Acetas
,, Nitras
,, Citras
,, Tartras
,, ,, Acida.
,, Bicarb.
,, Carbonas
,, Sulphas
Sodii Bicarbonas
,, Acetas
,, Citro-Tartras
Soda Tartarata
Ammonii Chloridum
Ammonii Acetatis Liquor
Ammonii Citratis Liquor
Lithii Carbonas
,, Citras
Lime Salts in Mineral Waters</td><td rowspan="3">Juniperus
Copaiba
Ol. Terebinth.
Sabina
Piper
Cubeba
Salicylates
Caffeina
Uva Ursi
Pareira
Buchu
Arnica
Aconitum
Scoparium
Guaiacum
Cambogia
Cantharis
Volatile Oils
Oleo-Resins
Resins
Balsams
Jaborandi
Lobelia
Dulcamara
Alcohol</td><td>Iodum
Hydrargyrum</td><td rowspan="3">Opium
Belladonna
Hyoscyamus
Stramonium
Uva Ursi
Buchu
Pareira</td></tr>
<tr><td>URINARY ACIDULATORS.
Acid. Salicylic.
,, Benzoic.
,, Citric.
,, Tartaric.
Mineral Acids</td><td rowspan="2">RENAL DEPRESSANTS
Morphina</td></tr>
<tr><td>RAISE GENERAL PRESSURE AND DILATE RENAL ARTERIES.
Digitalis
Scilla</td><td>TONIC DIURETICS.
Stomachics
Hæmatinics</td></tr>
</table>

CHAPTER XIV.

THE BODY HEAT, AND ITS REGULATION: THE SKIN.

I. PHYSIOLOGICAL RELATIONS.

HEAT is *produced* in every act of vital energy; is *distributed* throughout the body; and is finally *lost* in the surrounding medium. In so-called "cold-blooded" animals, the vital heat is lost as rapidly as it is produced; in "warm-blooded" animals the heat produced does not escape until a certain amount has *accumulated* within the system. Thereupon loss sets in, and exactly balances the production, whilst the accumulated store remains constant, and is known as the "body heat," amounting, in man, to 98·4 degrees Fahr.

So wide is the range, so sudden are the changes, of the external temperature to which man is exposed, and so variable the amount of heat produced in the system at different moments, that in the course of its evolution the body has come to possess a complex and sensitive nervous mechanism, by which its temperature is controlled. This mechanism consists of governing centres, afferent nerves from impressionable parts, and efferent nerves to active organs. *The afferent thermal nerves*, originating in the skin, and possibly in other parts of the body, such as the mucous membranes and viscera, carry impressions of temperature (heat and cold) to the brain and cord. There these impressions are specially received by three of the great centres, viz. the *cerebrum*, where they become *sensations of temperature;* the *sweat centres* in the cord and medulla; and the *metabolic or trophic* centres, the centres of nutrition, in the brain (? pons) and cord. They also fall into the vaso-motor, cardiac, respiratory, and possibly the renal and other visceral centres. *Efferent impulses* from the sweat centres proceed to the sudoriparous glands, which they stimulate or depress, as the case may be; from the metabolic centres they are directed to the various sources of heat production—the muscles, glands, etc., which they depress or stimulate. Through the other centres named the circulation in the skin is modified, the blood pressure generally, the respiration, the renal secretion, and probably every other bodily function in some degree.

Thus, when the temperature of the air rises, the regulative mechanism comes into action, and two great effects are produced: (1) there is *increased loss of heat* by the perspiration, by cooling of the blood in the dilated cutaneous vessels, and by cooling of the blood in the lungs; and (2) there is *diminished production of heat* in the muscles, glands, etc. The same effect follows a rise of the internal temperature due to increased metabolic activity, such as muscular exercise: a "warm glow" is felt, the skin flushes and perspires, the circulation and respiration are increased, and the activity of other metabolic organs, such as the liver, is for the time lowered. The skin is the principal channel of loss of heat in man; but during and after exertion a large amount of heat must be carried off by respiration, which is familiarly known to be the chief means of refrigeration in the dog.

Conversely, if the temperature of the surface be *lowered* by cooling of the atmosphere, two reflex effects are at once produced through the nervous system, viz.: (1) *diminished loss* of heat, by contraction of the vessels of the skin, by arrest of perspiration, and by reduced activity of the circulation and lungs; and (2) *increased production* of heat in the metabolic organs, especially the muscular, digestive, and circulatory. A similar result follows lowering of the internal temperature by diminished metabolism in some of the organs. Thus Quinine and Salicylic Acid, whilst they diminish the amount of the urea and therefore probably of the heat produced in the system, make little or no impression on the temperature of a healthy man, doubtless because the channels of loss are partially closed, and the metabolism of certain organs increased, by the regulating mechanism.

II. PHARMACODYNAMICS.

1. *Temperature of the External Media.*—This is completely under our control. The atmosphere is the ordinary external medium of loss or gain of the bodily temperature, and the air of every well-constructed room or ward can be warmed or cooled at pleasure. We may select the *climate* in various ways, according to its temperature; the sub-tropics, such as Madeira, Egypt, and the Riviera, being especially valuable as affording warm climates. When a more rapid and extreme influence of the external temperature is desired, *water* may be substituted for air, in the form of baths, wet-packs, and sponging. The varieties, action, and uses of water applied in these several ways are described in the next chapter. By means of the *prolonged cold* bath, at a temperature varying between 32° and 60° Fahr., heat may be readily abstracted from the body; and the cold wet pack, cold affusion, or sponging a part or the whole of the exposed skin with cold or even tepid water, has a similar effect. These measures are known as **external refrigerants.** Heat may be *locally* abstracted by similar means, which will also have a general effect in reducing the temperature of the body. Thus, cold water may be injected into the rectum or vagina; ice or wet compresses applied to the skin; ice or cold water swallowed; or

irrigation with cold water may be used over a part. The cooling that attends evaporation is a powerful means of reducing the local temperature; and a variety of saline, spirituous, and acid solutions, such as Carbonate or Chloride of Ammonium, Spirit and Water, Brandy and Water, Vinegar and Water, or various combinations of salts, acids, and spirits, may be employed for this purpose.

2. *The Cutaneous Circulation.*—This affords us a powerful means of abstracting the body heat, inasmuch as we can modify the fulness of the vessels and the rate of flow through them. Thus we may cool the blood by dilating the cutaneous vessels by the warm bath, by Alcohol, Spirit of Nitrous Ether, or warm draughts, or by these measures combined. Opium and Chloral have the same effect. If the blood-flow be accelerated through the dilated vessels, the refrigeration is increased, and in this way cardiac stimulants of every kind, such as Alcohol and Digitalis, reduce the body temperature. Draughts of water, whether cold or hot, temporarily distend the vessels, and produce a similar effect. The opposite methods for preserving the heat of the body, by contracting the superficial vessels and reducing the activity of the cutaneous circulation, are of no therapeutical interest.

3. *The Sweat-glands: Diaphoretics, Sudorifics, Anhidroties.*—The function of perspiration is under our control in almost every portion of its complex mechanism.

a. Measures which increase the amount of perspiration are called **diaphoretics** or **sudorifics**. The *afferent thermic nerves* in the skin can be readily stimulated by means of heat, as described in chapter xv., whether by moist heat in the form of the warm water- or vapour-bath, or various kinds of pack; by dry heat, as in the Turkish bath; or by general warmth of the air, of the room, or of the clothing. The familiar effect of Alcohol in inducing perspiration appears to be chiefly produced in the same way. *Other afferent nerves* may be used to stimulate the sweat-centres reflexly, such as those of the mouth throat, and stomach by hot spiced drinks. Perspiration may be induced by acting on the *perspiratory centre* directly. This may be accomplished by measures which increase the venosity of the blood, such as narcotics, including Opium, Chloral, Chloroform, Ether, and Alcohol in the later stages of their action; by Nicotin (Tobacco), by Pilocarpine (Jaborandi) in part; and by all measures which increase the flow of warm blood through the sweat-centres, such as hot drinks. The *efferent nerve-trunks* of perspiration may be stimulated by electricity, but this method is not therapeutically employed. The *terminations* of *the nerves* in the sweat-glands and the secreting cells can be powerfully stimulated by Pilocarpine, which causes an exceedingly profuse and rapid flow of sweat. Diaphoresis will be favoured by a free supply of blood to the glands, *i.e.* by *dilating the vessels*, as just described. A number of substances induce diaphoresis without their mode of action being clearly understood, such as Citrate of Ammonium and especially Acetate of Ammonium, which possibly stimulate the secreting cells, and are excreted by them along with an increased amount of water, as we see in the kidney; Antimony; Dover's Powder; the aromatic substances in a degree, especially Camphor; and several empirical remedies, viz. Serpentary, Sassafras, Sarsaparilla, Guaiacum, Mezereon, and Senega.

It will be observed that several of our powerful diaphoretics act on more than one part of the perspiratory mechanism. Thus Alcohol dilates the cutaneous vessels, increases the rate of blood-flow through the skin, and stimulates both the afferent nerves and the centres of perspiration. Warm applications to the skin and hot drinks also influence both the circulatory and the perspiratory part of the refrigerating function; and by a combination of these and other means we may produce a very powerful effect. When this is the result, and the sweat flows abundantly from the surface, the measures and result are said to be **sudorific** (*sudor*, sweat, and *facio*, I make.)

(*b*) *Measures which diminish* the amount of perspiration are called **anhidrotics** (ἀν, priv., and ἱδρῶς, sweat.) Some of these act upon the *afferent* nerves, especially moderate local cold, obtained by fanning, light clothing, and a cool atmosphere generally; and sponging with cool, tepid, or even hot water. Others depress the perspiratory *centre*—possibly in part directly, certainly indirectly by strengthening the heart and respiration, and thus reducing the venosity of the blood which powerfully stimulates it. Such are food, which is one of the best means of preventing the "cold sweats," of exhausting diseases, Alcohol, Ammonia, Strychnine, Iron, and fresh air or good ventilation. The *efferent* sweat nerves may possibly be depressed by Opium, which in certain combinations, *e.g.* with Diluted Sulphuric Acid, is an anhidrotic, acting either in this or some unknown way. By far the most powerful anhidrotic drugs act upon the *terminations* of the perspiratory nerves in the glands, namely, Atropine and Hyoscyamine. The effect of these alkaloids or of the Extract of Belladonna is very marked. Measures which contract the blood-vessels of the glands will *pro tanto* be anhidrotic also. Such are: sponging with solutions of Sulphuric Acid and Water or of Tannin, which constringe the parts, and Oxide of Zinc given internally.

Lastly, the *modus operandi* of certain anhidrotics is still doubtful, and their employment so far empirical, *e.g.* Zinc, Quinine and Opium under particular circumstances. It is possible, however, that these and other measures control the pathological cause of the sweats, in a manner to be afterwards indicated.

4. *Other Channels of Loss of Heat.*—The kidneys and the bowels afford us a direct means of reducing the temperature of the body by tho abstraction of an increased amount of warm excretions, in the form of urine and watery motions. In the case of the bowels the effect is decidedly assisted by the reflex dilatation of the cutaneous vessels which accompanies purgation, as described in chapter vi.

5. *The Heat-forming Tissues.*—In discussing metabolism in chapter ix., we found that we possess the power of diminishing tissue change, and the production of heat, by various means. Here we shall refer only to certain drugs which possess this action. We call these **antipyretics** (ἀντὶ, against, πυρετὸς, fever). The most powerful of these is Cinchona (Quinina), which interferes with metabolism generally, lessens the amount of heat produced, diminishes the excretions, and spares the organs. Salicin and Salicylic Acid, Antipyrine, Chinolin, and Kairin, have a similar but less powerful action. Whilst these drugs distinctly reduce or spare the activity of the tissues, they have but little influence in reducing the temperature of healthy individuals, this effect probably being prevented by the ordinary mechanisms of regulation. Alcohol also diminishes tissue waste, apparently in a different way from Quinine, viz. by being itself decomposed in the tissues with great readiness, thus sparing the organs. Even an increased amount of heat is generated in the tissues by the oxydation of Alcohol, but so greatly does it stimulate refrigeration, as we have seen, that its total effect on the organism is antipyretic. The Aromatic substances have a less powerful influence in diminishing metabolism. Possibly, Digitalis, Aconite, and Veratrine, have also an antipyretic effect, like Alcohol, but their mode of action is obscure, unless it occur entirely through the circulation, as has been already suggested.

III. PATHOLOGICAL RELATIONS.

The mechanism concerned in the regulation of the body-heat is liable to disorder, when heat-forming or heat-losing organs are diseased. Elevation of the body temperature, or *pyrexia*, most commonly called *fever*, is very rarely absent in illness of any consequence. An abnormal fall is seen as an effect of extreme cold or of exhausting diseases, but being comparatively insignificant does not require to be discussed here.

Pyrexia.—The temperature of the body may be abnormally raised in several ways. Thus we meet with excessive pyrexia in injury or disease of the *heat-centre* or *tracts*, especially injury of the cervical and dorsal regions of the spinal cord. *Exposure to excessive heat* induces "heat-fever," a variety of sunstroke which is common in India. More familiar to us is fever brought on by *interference with the refrigerating function of the skin*, as the effect of exposure to cold or damp. This is known as a "chill." A powerful impression of cold on the afferent nerves of temperature appears to throw the regulating mechanism into disorder; perspiration is arrested; the cutaneous vessels are spasmodically contracted; rigors, shivers, or chilly feelings ensue; and the heat thus retained in the blood quickly raises the temperature.

Increased production of heat at one focus, such as an inflamed part, contributes in an insignificant degree to the accompanying fever.

The increased production of heat in the tissues generally which is probably present in all kinds of fever, whatever its cause, is no doubt the principal origin of the pyrexia. The increased activity of metabolism is proved by the rapid wasting of the tissues, by the increase of urea and other excretions, and by the pyrexia as tested by the thermometer—all obvious phenomena in every case attended by fever.

In the specific fevers there is at work, however, another cause of oxydation of the tissues, which furnishes an *extraneous* addition to the body heat. We now believe that many diseases, such as typhoid fever, small-pox, and septicæmia, are associated with the presence of organisms in the tissues, if not actually caused by them. The life of such organisms, the processes of fermentation with which they are associated, and the destruction of the tissues which they produce, must all be a considerable source of heat within the body, in a way perfectly foreign to the normal processes, though closely resembling some of them.

A combination of several of the preceding causes is commonly at work in fever. Thus, when a patient has a local wound which acts as a focus of heat, the pus may decompose, *i.e.* become infected by organisms; these are absorbed into and flourish in the blood; fresh foci of disease are set up in the tissues; and the natural refrigeration of the blood is reduced by the disturbances of the skin, lungs, and circulation, which always accompany serious illness.

Disorders of Perspiration.—Only two disorders of perspiration concern us here, viz. (1) *excessive sweating*, and (2) *deficient sweating.*

1. *Excessive sweating, hidrosis, hyperidrosis*, is found in a great variety of morbid conditions. In some kinds of fever, such as rheumatism, its pathology is bound up with the pathology of the fever as a whole. In disorders of respiration, as we have seen, dyspnœal sweats are due to stimulation of the sweat-centres by venous blood. The "cold" sweats of wasting diseases such as phthisis, especially during sleep, appear to be due to the same cause, associated with anæmia and coldness of the skin, which prevent evaporation and "insensible perspiration," and thus give rise to a profuse collection of visible sweat as well as great depression of the bodily strength from interference with the cutaneous excretion. "Critical" sweats are referred to sudden changes in the disturbance of the vaso-motor system of the skin present in fever. Toxic sweating, as is seen in alcoholism and gout, may obviously be variously induced.

2. *Deficient sweating : anhidrosis.*—Dryness of the skin occurs at the beginning of most fevers, and throughout the course of most of them more or less interruptedly. It is also marked in some diseases and disorders of the urinary functions, such as Bright's disease and diabetes; in certain diseases of the skin itself; and as the result of poisoning by atropia (belladonna), etc. Manifestly different parts of the nervo-glandular apparatus are disordered in the different cases.

IV. NATURAL RECOVERY.

Disorders of the body heat being disturbances of a regulating mechanism, that is, of one means of natural recovery, we can hardly expect to find at work in fever those very provisions which have been interfered with. For the same reason, the temperature of the body generally returns to the normal on the cessation of the cause of the fever, either spontaneously or with the artificial assistance of the therapeutist. Occasionally the temperature rises beyond all control—to 107°, 110°, and even higher, and the subject dies of the effects of excessive heat or *hyperpyrexia.* In most instances of death from fever, however, the fatal result is due to one of the other factors of fever, especially the body waste.

V. THERAPEUTICS.

A great part of our knowledge of the body heat, its regulation and its disturbances, has been derived from careful observation of the results of treatment; and the use of measures to control fever—antipyretics or **febrifuges** (*febris*, fever, and *fugo*, I drive away,) is one of the most successful, as well as rational, of therapeutical proceedings.

1. *Preventive Treatment: Antiperiodics.* — The periodical return of fever may be prevented by means of **antiperiodics.** The most powerful of these is Cinchona, with its constituents, especially Quinine; Salicin, Salicylic Acid, and Chinolin, are not so powerful; less important are Nectandra and its alkaloid Beberine.

2. *Immediate treatment.*—With the abundant means at our command which we have discussed in the second section, the immediate treatment of pyrexia is very easy, inasmuch as we can lower the temperature of the surface of the body to any degree we please; for instance, by the cold bath. But we soon discover that it is one thing to reduce pyrexia, and another thing to treat fever. We can readily assist the refrigerating mechanism of the body, and we can even so far reduce the metabolic activity of the tissues, but our remedies can rarely reach the actual cause of the disorder, and the temperature rises again. As far as possible, however, we are bound to begin by discovering and attacking the causes; and if we fail in this, we must then combat the fever itself, so as to prevent its injurious effects on the system.

(*a*) *Injury or disease of the nervous system*, as a cause of pyrexia, is generally beyond treatment. If the temperature rise to a dangerous height, it must be treated by the refrigerating measures presently to be described.

(*b*) *Heat-fever* is rationally treated by immediate removal of the patient to a cool, open atmosphere, and the application of refrigeration, in the form of cold affusion.

(*c*) *Interference with the cooling function of the skin* is rationally treated by increasing the loss of heat by refrigerants. Refrigeration is practically carried out by lowering the temperature of the external medium, by increasing the cutaneous circulation, and by stimulating the secretions by the warm bath, by hot, spiced alcoholic drinks, or by a brisk purgative.

When fever rises high, the temperature of the room must be kept low, and the skin sponged; and if the pyrexia rise to a dangerous height, the prolonged cold bath or wet pack must be employed according to the method described in chapter xiv.

Diaphoretics are chiefly employed as refrigerants in symptomatic fevers, *i.e.* in the pyrexia attending ordinary local inflammation of the lungs, bronchi, fauces, or other parts. Alcohol, Hot Water, Liquor Ammonii Acetatis, Ipecacuanha and Opium in the form of Dover's Powder, Antimony as the

Pulvis Antimonialis or Vinum Antimoniale, and Tincture of Aconite are the drugs chiefly used to provoke perspiration in fever. With these, the use of the warm bath may be combined.

(*d*) *A focus* of increased heat-production, such as an abscess, must be removed as soon as possible.

(*e*) *Increased metabolism generally*, which is the principal cause of pyrexia, is rationally treated by Quinine, Salicin, Alcohol, the Phenol Derivates, and Aromatic Substances. The rule commonly followed is to give a single large dose of Quinine, say 10 grains, when the temperature rises above a certain point, 104° or 105°, according to circumstances; or repeated moderate doses or a single large dose may be given in anticipation of tho exacerbation. Ague is thus combated by Quinine, and rheumatism by Salicin or the Salicylates.

(*f*) *Foreign organisms or substances in the system.*—Fever produced by these bodies and their lifo-processes would be rationally treated by destroying them. We attempt to do so by administering internally some of the substances which are destructive to lowly organised life apart from the body, or in wounds on the surface of the body, the antiseptics and disinfectants, and which may be named **disinfectant antipyretics.** The value of Quinine in ague is so great, that it is referred to a specific influence upon the organism of the disease. The powerful effect of Salicin upon rheumatism has been similarly explained.

(*g*) *Combinations of causes.*—Just as fever is generally traceable to a combination of the preceding causes, so it must, as a rule, be treated by the application of remedies which act in several ways, or by a combination of antipyretic measures. Thus Alcohol will be indicated in many cases of fever, because it dilates the vessels of the skin, increases the circulation through them, and stimulates the sweat glands, whilst it spares tissue damage, and acts as an antiseptic antipyretic. Quinine will be employed with advantage when the temperature mounts high, since it controls the metabolism not only of the animal tissues, but of the septic and foreign organisms which may be wasting these. Indeed all the measures which we have analysed under the preceding heads are to be freely combined, constituting the general treatment of fever. An abundant supply of nutritious and digestible food is essential, to compensate for the great increaso of metabolism which is going on. Alcohol is a true food, easily taken, rapidly assimilated, and yielding abundance of energy at little cost to the tissues, and therefore it is in general use in fevers, although it is by no means an indispensable remedy.

SYNOPSIS OF SUBSTANCES ACTING ON THE BODY HEAT.

ANTIPYRETICS.	ANTIPERIODICS.	REFRIGERANTS.	ANHIDROTICS.
Antimonium Acidum Salicyl. Salicin Benzoinum Storax Camphora Nectandra Beberina Piper Quinina Opium Arnica Lobelia Alcohol Resorcin Chinolin Antipyrine Kairin Aconitum Acids Eucalyptus Chloral Hydras Veratrina Colchicum	Quinina Acid. Arsenios. Piper Eucalyptus ? Resorcin DIAPHORETICS. Jaborandi Opium Antimonium Resorcin Aqua Ipecacuanha Senega Camphora Cubeba Colchicum Salicin Acid. Salic. Lobelia Arnica Alcohol Aconitum Pot. Citras Pot. Nitras Am. Acet. Liq. Am. Chloridum Am. Cit. Liq.	*Stimulants of the Cutaneous Circulation.* Digitalis Scilla Alcohol *Dilators of Cutaneous Vessels.* Chloral Hydras Digitalis Scilla Alcohol Veratrina	Quinina Belladonna Stramonium Hyoscyamus Alcohol, Evaporating Acids, locally in solution Ergota Picrotoxin Zinci Oxidum Acidum Sulphuricum Dilutum Acidum Salicylicum

CHAPTER XV.

THERAPEUTICAL PROCESSES CONNECTED WITH THE SURFACE OF THE BODY.

The surface of the body is of great interest and importance to the therapeutist, because it is the region of objective impressions, where influences of every kind may be brought in contact with nerves and vessels, and through them with the nervous centres, the circulation generally, and indeed the entire system. The measures applied to this part appear at first sight to be very simple, but their action is, on the contrary, extremely complex, and indeed still very obscure. On this account we have taken them last in the whole range of remedies, and it will be found that they involve all the systems already discussed, especially the nervous and circulatory. As a group they are very heterogeneous, and we will select for special consideration three distinct subjects, namely (1) *Counter-irritants*, such as blisters; (2) *Baths;* and (3) *Surgical Applications.*

I. PHYSIOLOGICAL RELATIONS.—The physiological relations of the surface of the body have already been studied under several distinct heads.

The *nerves* are connected not only with the sensorium, but with the vital centres which regulate the vessels and viscera. The cutaneous *vessels* have equally extensive relations. They have the usual nutritive function; they are the great refrigerating apparatus of the body; and they also serve as a great external blood-reservoir, in connection with the systemic circulation.

II. PHARMACODYNAMICS.—When the classes of measures given at the ends of the chapters on the circulation and nervous system are compared, it is found that several of them act on both, and that their action may be different or even opposite according to the time for which they are applied. For these and other reasons, a number of them have been collected into a special class, and called

Counter-irritants.—These measures may be thus arranged, according to the degree of their action:

1. **Rubefacients** (*rubere*, to be red, and *facere*, to make) cause increased redness and heat of the parts. Such are Hot Water; Mustard, and its preparations; Ammonia, and its preparations; the confined vapour of Chloroform, Ether, and Alcohol; all Volatile Oils, especially Turpentine, Camphor, Menthol and Thymol; Iodine carefully applied; Emplastrum Picis; and Emplastrum Calefaciens.

2. **Vesicants** (*vesica*, a blister), **Epispastics** (ἐπι, upon, and σπάω, I draw), or **Blisters**, produce a rubefacient effect, followed by the development of a blister. They include Cantharides, Mezereon, Ammonia long applied or confined, Iodine, Oil or Compound Liniment of Mustard, and Scalding Water.

3. **Pustulants** (*pus*, matter) produce a crop of pimples. They are a small group, consisting of Croton Oil, Tartar Emetic, Nitrate of Silver in strong solution, and Ipecacuanha.

Phenomena of counter-irritation.—When a counter-irritant is applied to the skin, the *first* effect is *rubefacient* and stimulant. The cutaneous vessels are dilated by a direct action on their nerves, and the local circulation becomes more free; whilst the irritation of the sensory nerves causes pain of a hot burning character. The cardiac action is accelerated, the cutaneous vessels generally reflexly contracted, the blood pressure rises, the temperature is elevated, and the breathing slowed. The highest centres are also roused by the painful impression: perception, consciousness, and the emotions are variously disturbed. Cutaneous anæsthesia follows: the nerves are depressed, pain is relieved, excepting that caused by the application itself.

Prolonged application is generally required to induce the *second* degree of counter-irritation—*vesication.* The reddened area now becomes inflamed; plasma escapes from the vessels, followed by corpuscles; the epidermis is raised, and a vesicle is formed containing a quantity of fluid. The previous anæsthesia is now replaced by considerable local pain, which, if extensive, may depress the viscera—weakening and slowing the heart, lowering the pulse, further slowing the respiration, lowering the temperature and diminishing nervous energy.

The *third* degree of counter-irritation, *pustulation,* is different in kind from vesication as well as more severe, the result being not uniform inflammation, but a crop of painful, "angry" pimples or pustules, which are very slow to heal. The remote effects are the same as before, but greater.

Theory of the action of counter-irritation.—Such are the phenomena of this method, obvious to all. But it is held by some that not only the functional activity, but the *nutrition* of internal parts may be affected by means of it. The doctrine of counter-irritation may be said to be, that when a part at some distance beneath the surface of the body, such as a joint, or even remote from it, such as the lungs, is in a condition of inflammation, pain, unnatural activity, or overgrowth, an alterative effect may be produced upon its nutrition, by altering the condition of an area of skin superficial to it, or even at a distance from it. A second or "counter" seat of "irritation" is set up to relieve the deeper and more vital part. Now we may conclude with respect to this theory.

1. That rubefacients and vesicants will afford relief to the circulation of parts in immediate vascular connection with the selected area, by attracting blood and draining off plasma; to the same extent the general circulation will be depressed, and visceral congestion or inflammation will be diminished. At the same time the heart will be relieved.

2. That the irritation of the cutaneous nerves will modify in a simple reflex way, through the centres in the brain and cord, the circulation and nutrition generally, of the parts beneath; the impression which passes in being immediately reflected along the vascular or trophic nerves.

3. That possibly the irritation of the local nerves and vessels may affect the vaso-motor and trophic centres in the brain and cord, presiding over the area of skin; and that this disturbance may so influence a neighbouring trophic centre (say of a joint) as to produce through it a change in the nutrition of the tissues (such as a joint) in the neighbourhood of the area to which the irritant was applied.

4. That vesicants and pustulants may produce a flow of plasma or pus, which will relieve the blood or tissues of organised or other poisons, which are the cause of the disease. This is the old humoral view, founded on the pathology that "humours of the blood" are the origin of disease.

III. PATHOLOGICAL RELATIONS AND THERAPEUTICS.—The pathological conditions which we seek to influence by counter-irritants belong to various systems, which have been already discussed. The same remark holds true of the therapeutical applications of the principles just examined. All that remains to be done here is to enumerate the chief morbid conditions which may be treated by counter-irritation. These are, (1) Subacute or chronic inflammation, with or without unnatural growth, of parts in direct vascular connection with the skin; *e.g.* of a joint or bone. (2) Congestion or inflammation in neighbouring viscera; *e.g.* of the lungs. (3) Pain in deep or distant parts, such as neuralgic, cardiac, or renal pain. (4) Spasm, or other morbid activity in deep muscular structures, such as lumbago and vomiting. (5) Central nervous disturbances such as syncope and hysteria.

Baths and Allied Measures.—The principles on which the use of baths depend are in a great measure identical with those which we have already discussed, and do not require to be repeated. If the student will carefully bear in mind the relations of the vessels and nerves of the skin to the body heat, circulation generally, and nervous system, he will readily appreciate the subject of baths from the following tables, which give a list of the most common baths, together with their action and principal uses succinctly arranged.

I. WATER BATHS.

Name.	Temperature.	Action.	Uses.
Cold.	32° to 60°	Cools blood in cutaneous vessels; stimulates heart, respiration, etc., reflexly. Temporarily overfills internal vessels, thus raising blood pressure.	Refrigerant in fever. Refreshing: The morning bath.
Cool.	60° ,, 70°	The same, but less marked.	The same in weaker subjects.
Tepid.	85° ,, 95°	Detergent (cleansing), physically and chemically; soothes the nerves.	Ordinary personal cleanliness. Allays restlessness of fever and lowers temperature.
Warm.	95° ,, 100°	Raises local temperature; stimulates local circulation; stimulates glands, increasing discharge of warm secretions, and evaporation; soothes the nerves and the corresponding centres.	Diaphoretic in fever; diaphoretic in uræmia; anodyne; antispasmodic.
Hot.	100° ,, 106°	The same, but more marked.	The same, but is more powerful.
,, Local.	,, ,,	Attracts blood *to* part bathed.	To stimulate menstrual flow.
,, ,,	,, ,,	Attracts blood *from* distant parts.	To relieve internal congestions, as in catarrh and apoplexy.

II. VAPOUR BATHS.

Name.	Temperature.	Action.	Uses.
Simple Vapour or Russian.	95 to 110°	Much like the warm or hot bath, but slower, and at higher temperature.	Much like the warm bath. A powerful diaphoretic.
Medicated watery Vapour.	,, ,,	The action chiefly of aromatics.	Stimulant and antispasmodic.
Fumigations.	Various.	Specific (Mercury, Sulphur, etc.).	Specific.

III. AIR BATHS.

Name.	Temperature.	Action.	Uses.
Hot air, or Turkish.	Up to 220°, followed by cold.	Diaphoretic, followed by stimulation; anodyne; increases metabolism.	Like warm water and Russian baths. Tonic.
Compressed air.	Ordinary.	Increases oxygenation.	Diseases of the lungs and heart.

IV. MEDICATED BATHS.

Name.	Temperature.	Action.	Uses.
Natural.	That of the spring.	Specific.	Gout, rheumatism, syphilis, skin diseases, etc.
Sea.	Various.	Stimulant.	Invigorating.
Artificial.	Various.	Specific, *e.g.* Nitro-hydrochloric Acid, Sulphide of Potassium, and Mercurial solutions.	As alterative in hepatic disease, rheumatism, syphilis, plumbism, scabies, and other skin diseases.

V. COMPLEX BATHS.

Name.	Temperature.	Action.	Uses.
Mercurial and vapour.	Sufficient to vaporise water and mercurial.	Specific.	Syphilis.
Mercurial and hot air.	Sufficient to vaporise mercurial.	Specific.	Syphilis.
Mud, pine, bran, etc.		Various.	Various.

The cold bath in fever.—A simple tepid water bath is prepared, at a temperature of about 90°; the patient is carefully placed in it; and cold water is added until the thermometer falls to 80° or even 40°, according to circumstances. Here the patient remains for 10 to 20 minutes, his temperature being taken during immersion, or if any shivering occurs, he is at once removed. He is then wiped dry, placed in bed, and covered with blankets. A stimulant may be required. The cold bath may be repeated several times a day, if indicated.

In very urgent or desperate cases the cold bath may be increased in activity by lowering the temperature to freezing point by ice, and by prolonged immersion, even to three hours. This treatment requires great care and judgment.

The douche, affusion, and shower bath. — The stimulant action of water may be greatly increased by directing it against the body in a single or divided stream. The size, height, direction, and temperature of the stream, the part and extent of surface to which it is applied, have great influence upon the effect of the douche. The *uses* of the shower bath are chiefly in hysteria and mania; of the local douche in loss of sensibility of parts, chronic enlargements of joints or bones, and sprains. Affusion is of value in convulsions, sunstroke, mania, hysteria, and as a means of resuscitation.

The Wet Pack.—Prepare a bed by spreading two blankets on the mattress and over the pillow of an ordinary single bedstead. Thoroughly wet a linen sheet with cold water, and spread it smooth over the blankets. Strip the patient, place him flat on his back on the wet sheet with his head on the pillow, and envelop him in the sheet and blankets, by bringing these one side at a time across his body, and tucking them under the opposite side and under the heels. Finally cover him with several more blankets, and again tuck these closely round him. The ordinary duration of packing is a quarter of an hour to an hour. The pack is then removed, and the skin rubbed with a dry towel. The pack may be repeated several times a day if necessary.

The first sense of chilliness produced by the wet sheet is quickly replaced by a delightful glow. The physiological action of the wet pack is chiefly on the refrigerating function of the skin: heat is abstracted so that the temperature quickly falls; the frequency and force of the pulse decline; the central nervous system is soothed both through the nerves and through the circulation, and by the refrigeration; sensibility, pain, irritability, and delirium, are dispelled; and sleep often follows immediately.

The *use* of the wet pack is almost confined to the specific fevers, such as scarlatina and typhoid, when the pyrexia is excessive, delirium high, and the rash ill-developed.

The Treatment of Wounds.

1. **Antiseptics** prevent putrefaction in a wound by virtue of their action in arresting the growth of organisms, or destroying these or the chemical activity of certain substances which give rise to fermentation and decomposition. They include: Carbolic Acid, Creasote, Boracic Acid, Iodoform, Iodine, Eucalyptus, Thymol, Salicylic Acid, Quinine, Sulphurous Acid, Perchloride of Mercury, Chloride of Zinc, Alcohol, Permanganate of Potassium, Turpentine, Benzoin, Balsam of Tolu, and Balsam of Peru.

2. **Disinfectants** are substances which destroy micro-organisms, or active chemical substances and their products, on surfaces already foul or infected. They are for the most part the same materials as the antiseptics, but are employed in a much stronger form. Such are strong solutions of Chloride of Zinc and Carbolic Acid, Iodoform, Iodine, Sulphurous Acid.

3. **Deodorants** absorb gases and neutralise foul odours. Those chiefly used are Charcoal, Permanganate of Potash, and Iodoform.

4. **Astringents** coagulate or precipitate the albuminous discharges, coagulate the germinal protoplasm of the upper layers of cells, and either directly contract or indirectly constringe the vessels, so as to limit exudation. They are used to check excessive discharge and granulation growth; and thus give tone to wounds. Astringents include: Solutions of Nitrate of Silver, Subacetate and Acetate of Lead, Sulphate of Zinc, Sulphate of Copper, Alum, Persalts of Iron, Tannic Acid and its allies, and Carbolic Acid.

5. **Stimulants** are for the most part mild astringents, applied chiefly in the form of lotion; such as weak solutions of Nitrate of Silver, Sulphate of Copper, Sulphate of Zinc, Carbolic Acid, etc. They are more efficacious as weak spirituous solutions. Stimulants are used to wounds when healing flags or the granulations tend to become prominent.

6. **Styptics** are applied to wounds to check hæmorrhage. They include: Ice, Persalts of Iron, Nitrate of Silver, Matico, Tannic acid.

7. **Caustics and Escharotics** are intended to destroy part

of the living tissues, and thus destroy or arrest the activity of organic poisons, as in bites, dissection wounds, syphilis, malignant disease, and gangrenous processes. They include: Caustic Alkalies, Mineral Acids, Solution of Chloride of Antimony, Chloride of Zinc, Nitrate of Silver, Sulphate of Copper, Arsenic, Acid Nitrate of Mercury, and Dried Alum.

8. **Vesicants** are applied to chronic ulcerating surfaces to stimulate the circulation in the surrounding parts, and soften callous edges. Cantharides is chiefly used.

9. **Anodynes** are intended to alleviate the pain of wounds and ulcers, and induce sleep. The medicinal anodynes commonly thus applied are preparations of Opium and Belladonna.

APPENDIX.

SUBSTANCES WHICH ACT ON THE PUPIL.

PUPIL DILATORS : MYDRIATICS.	PUPIL CONTRACTORS : MYOTICS.
Belladonna Atropina	Physostigma Eserina
Stramonium Hyoscyamus Hyoscyamina Duboisina	Jaborandi Pilocarpina
Homatropine	Opium Morphina
Gelsemium	
Cocaina	

SUBSTANCES WHICH ACT UPON THE GENERATIVE ORGANS.

SUBSTANCES WHICH STIMULATE THE NON-GRAVID UTERUS : EMMENAGOGUES.	SUBSTANCES WHICH STIMULATE THE GRAVID UTERUS : ECBOLICS : OXYTOCICS.	SUBSTANCES WHICH DEPRESS THE UTERUS.
Myrrha	Ergota	Bromides
Aloes	Sabina	Opium
Ergota	Ruta	Chloral Hydras
Sabina	Pilocarpin	Cannabis Indica
Ruta	Drastic Purgatives	Chloroformum
Alcohol		Antimonium Tartaratum
Cantharis		Tabacum
Digitalis		Cupri Sulphas
Actæa Racemosa		Emetics
Purgatives		
Hæmatinics		
Tonics		

SUBSTANCES WHICH STIMULATE THE SEXUAL ORGANS : APHRODISIACS.	SUBSTANCES WHICH DEPRESS THE SEXUAL ORGANS : ANAPHRODISIACS.
Camphora (at first)	Bromides
Opium ,,	Camphora (at last)
Cannabis Indica	Opium ,,
Nux Vomica Strychnia	Tabacum
Phosphorus	Belladonna
Cantharis	Hyoscyamus
Alcohol	Stramonium
Lupulus	Circulatory Depressants
Hæmatinics	
Tonics	

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